Boston, Mass. Commercial and recreational boat traffic share the waterway. The waterway carries large numbers of yachts between the populous upper east coast of the Nation and the vacation areas of south Florida. Numerous side channels and basins with attendant berthing and service facilities have been developed, largely by local efforts, along the Florida section of the waterway.

15. In the area of Ponce DeLeon Inlet, the Intracoastal Waterway traverses the Halifax River to the north and the Indian River to the south except near Ponce DeLeon Inlet. At the inlet the waterway follows a cut through the marshes about a mile to the west. The waterway along those sections provides a depth of 12 feet with a width of 125 feet.

PLAN FORMULATION

16. Ponce DeLeon Inlet, located on the east coast of Florida about 10 miles south of the City of Daytona Beach, provides access to the Atlantic Ocean for commercial and recreational boaters. Fishing parties and shrimp and commercial fishermen bound for New Smyrna Beach or Daytona Beach use the inlet as well as others entering for an anchorage. Nearby fisheries enhanced by an artificial reef program attract both commercial and sport fishermen. Head boat operators also provide trips to view marine life and space shuttle launches from Cape Canaveral.

EXISTING CONDITIONS

17. Ponce DeLeon Inlet, shown in figure 2, is in Volusia County on the east coast of Florida, about 65 miles south of St. Augustine Harbor and 57 miles north of Canaveral Harbor. The inlet is a natural harbor connecting the Atlantic Ocean with the Halifax River and the Indian River North. According to historical accounts, the inlet has been in use for navigation for more than 200 years. In 1882, Congress provided for construction of a lighthouse that now exists on the north shore of the inlet. There is a U. S. Coast Guard Lifeboat Station on the east shore of the Indian River North about 0.7 of a mile south of the inlet.

18. Published Advice. According to the *United States Coast Pilot*, the inlet, protected at the entrance by jetties, is entered through a channel that leads over a bar and through the jetties. The outer end of the north jetty is marked by a light, and the inner end of the jetty is awash. With the constant shifting of the channel the Coast Guard has problems with navigation markers. The Coast Pilot publication does not advise passage through the inlet as buoys for the channel may not be marking the best water. Navigation through the inlet is also hampered by numerous recreational vessels anchored in the navigation channel along the south side of the north jetty. The publication advises that local knowledge and extreme caution be used in navigating the inlet.

19. Tides and Currents. The currents through the inlet are strong. It is reported that the average ebb is three knots; however, this can increase to five or six knots with southeasterly winds (probably meaning winds blowing from the southwest to the southeast). The mean tidal range is 2.3 feet (U.S. Department of Commerce, 1993).

20. Facilities. Ponce DeLeon Inlet connects with the Intracoastal Waterway (IWW) in two locations and provides access to the ocean from several communities in the Daytona Beach-New Smyrna Beach area. That area is within a 15-mile radius of the inlet.

21. Daytona Beach is a large resort city with excellent boating facilities and marinas to serve the public. The city has a municipal facility and dock with fuel, ice, water, and electricity available as well as meals and lodging nearby. Other facilities include two boatyards with a marine railway in each one for all types of repair, several marine hoists for repairs, and 225 open and covered berths with the same services as the public dock.

22. On the Halifax River between the inlet and Daytona Beach there are three communities with facilities for boaters. Port Orange is about 5.5 miles south of Daytona Beach with a boatyard and marina on the east side of the waterway. It is also the location of a commercial fishing facility. Inlet Harbor is a small fishing port on the northern channel of the Ponce DeLeon Inlet project about 0.5 miles southeast of the IWW. The facilities there include a marina with berthing, electricity, fuel, ice, water, some marine supplies, and a marine railway for repairs on small craft 65 feet or less in length. The third community of Ponce Inlet about one mile below Inlet Harbor has several small-craft facilities with berthing, electricity, fuel, water, ice, marine supplies, and marine railway for hull, engine, and electronic repairs on vessels 60 feet or less in length. Those communities also have facilities that handle existing charter and head boat operations.

23. To the south of the inlet along the Indian River portion of the existing Federal project is New Smyrna Beach about 2.6 miles from the inlet. Several small-boat facilities and a municipal marina provide services and supplies similar to those north of the inlet. Two commercial fishing facilities operate from New Smyrna Beach with fuel, ice, supplies, and berths for transient craft.

24. Traffic. Ponce DeLeon Inlet is the only access for recreational and commercial boaters in Volusia County to the ocean. Commercial traffic consists of charter and head boats as well as commercial fishing vessels. From available information obtained in local interviews both recreational and commercial use of the inlet are apparently heavy.

25. The Volusia County charter industry has been growing over the past 10 years. This is the result of an artificial reef program which has built 12 reefs within a distance of 6-12 miles offshore. Natural reefs are 25-30 miles offshore. The artificial reefs are very

attractive to sport fishermen. That attraction is what helps support the charter and head boat fleets in the vicinity of the inlet.

26. The charter and head boats use the inlet almost daily. On the average charter boats make 2,391 trips a year to carry about 16,380 persons of which 33 percent are residents and 67 percent are tourists. Head boats average about 1,872 trips a year through the inlet with 41,184 persons of which 64 percent are tourists and 36 percent are residents. About 40 percent of the charter boat trips and 50 percent of the head boat trips are to the artificial reefs.

27. Estimated recreational boat traffic, from local observations, in the inlet can range from 18,000 to 20,000 trips a year. That traffic comprises both local and transient boats from both inside and outside the county. Just in Volusia County boat registration records show over 17,000 recreational boats in the 1991-1992 license year. With the public parks on both sides of the inlet and the artificial reefs offshore, visitation on weekends is heavy and boaters from outside the local area are numerous.

28. Information from the Florida Cooperative Extension Service indicates commercial fishermen in Volusia County for the year ending in 1990 numbered 756. That source also had the number of commercial fishermen in the Port Orange area at about 100. Based on information in Florida Department of Natural Resources records, offshore commercial fishing trips (resulting in a landing of catch) numbered 5,614 in 1990 for Volusia County. The estimate is probably low considering transient and local traffic that enter and leave without landing a catch.

29. Commerce. The commercial fishing vessels handle the primary cargo through the inlet. From Marine Fisheries records in the Florida Department of Natural Resources landings in Volusia from July-December 1991 totaled 3,918,918 pounds. The offshore portion of that catch is an estimated 2,044,310 pounds. The catch consisted primarily of shrimp, grouper, snapper, mackerel, shark, swordfish, and tuna. Records from the Waterborne Commerce of the United States, Part I, for commerce through the inlet from 1984-1993 are in the following table:

Table 2 Waterborne Commerce [Amounts in pounds (000)]				
Year	Fish	Shellfish	Ice	Total
1995	1,000	1,000	NR	2,000
1994	NR	NR	NR	NR
1993	2,000	1,000	NR	3,000
1992	2,000	2,000	NR	4,000
1991	1,000	1,000	NR	2,000
1990	1,000	10,000	2,000	13,000
1989	816	126	1,000	1,942
1988	1,494	1,431	2,085	5,010
1987	1,226	528	1,912	3,666
1986	1,384	1,112	1,912	4,408
1985	851	1,695	2,160	4,706
1984	1,143	1,175	2,097	4,415

PROBLEMS AND OPPORTUNITIES

30. Since project construction was completed in July 1972, Ponce DeLeon Inlet has had operation and maintenance problems. Table 3 summarizes maintenance and additional work costs from FY-73 to FY-91 or since completion of the project. The costs shown are from the financial statements in the *Annual Report of the Chief of Engineers on Civil Works Activities* for years 1974-1991.

31. Channel Breakthrough Inside Inlet. A sand spit inside the inlet and adjacent to the western end of the north jetty underwent intense erosion just after completion of the north jetty. In February 1973, under the influence of a strong northeast storm, dramatic forces caused conditions in the area of the spit to deteriorate resulting in a breach. The breach occurred in a narrow sand section that was the old channel of the Halifax River. The old channel section still exists and is accessible from the Halifax River side of the spit. Appendix E contains a 1961 photo (#11) of the old channel before shoaling closed it in about 1964. When the breakthrough occurred, intense shoaling essentially closed navigation access to marinas located north of the old channel. The series of photos in appendix E numbered 1 through 10 show the inlet conditions leading up to and during the breakthrough (University of Florida, 1973).

32. The boatyard owner near the inlet and other commercial fishermen in the area provided information on the extent of the problem caused by the February 1973 breakthrough. The event, according to their records, caused shoaling in the channel to the boatyard along with part of the Halifax River channel to depths of approximately 2 to

3 feet. As a temporary measure to get around the problem, use of small, shallow-draft boats 16-18 feet in length provided a means of ferrying customers between the boatyard and their boats anchored in deeper water. The boatyard owner also sued the builder of the north jetty and the dredging company responsible for the original dredging of authorized channels to obtain relief.

33. Breakthrough Closure. Local businesses on the north side of the breakthrough experienced severe hardship as a result of shoaling. The difficulties with navigation caused a considerable amount of publicity for removal of the shoal blocking access to those businesses. The U.S. Army Corps of Engineers hired a small dredge to remove the shoal. The dredge could not successfully keep the channel open as shoal material deposited faster than it was being removed. The U.S. Army Corps of Engineers stopped dredging and closed the breakthrough. Once closed, a locally hired dredge was able to reopen the access channels. As a result of that breakthrough, local business owners in the vicinity of the breakthrough indicated that it took about two years for business to return to normal.

34. Maintenance. Closure of the breakthrough by August 25, 1974 involved use of material from the entrance channel and the impoundment basin at a cost of $517,153 and $582,198, respectively (U.S. Army Corps of Engineers, 1975). Other costs ($21,534) associated with the breakthrough involved the unsuccessful operation to dredge a channel in the cove north of the inlet which started July 3, 1973. The contract for that work was terminated at the convenience of the Government (U.S. Army Corps of Engineers, 1974). Since the 1973 breakthrough, changing conditions at the inlet caused extensive maintenance efforts to preserve the authorized navigation project as follows:

- Contract 77-B-0030 extended the landward end of the north jetty to station 55+00.

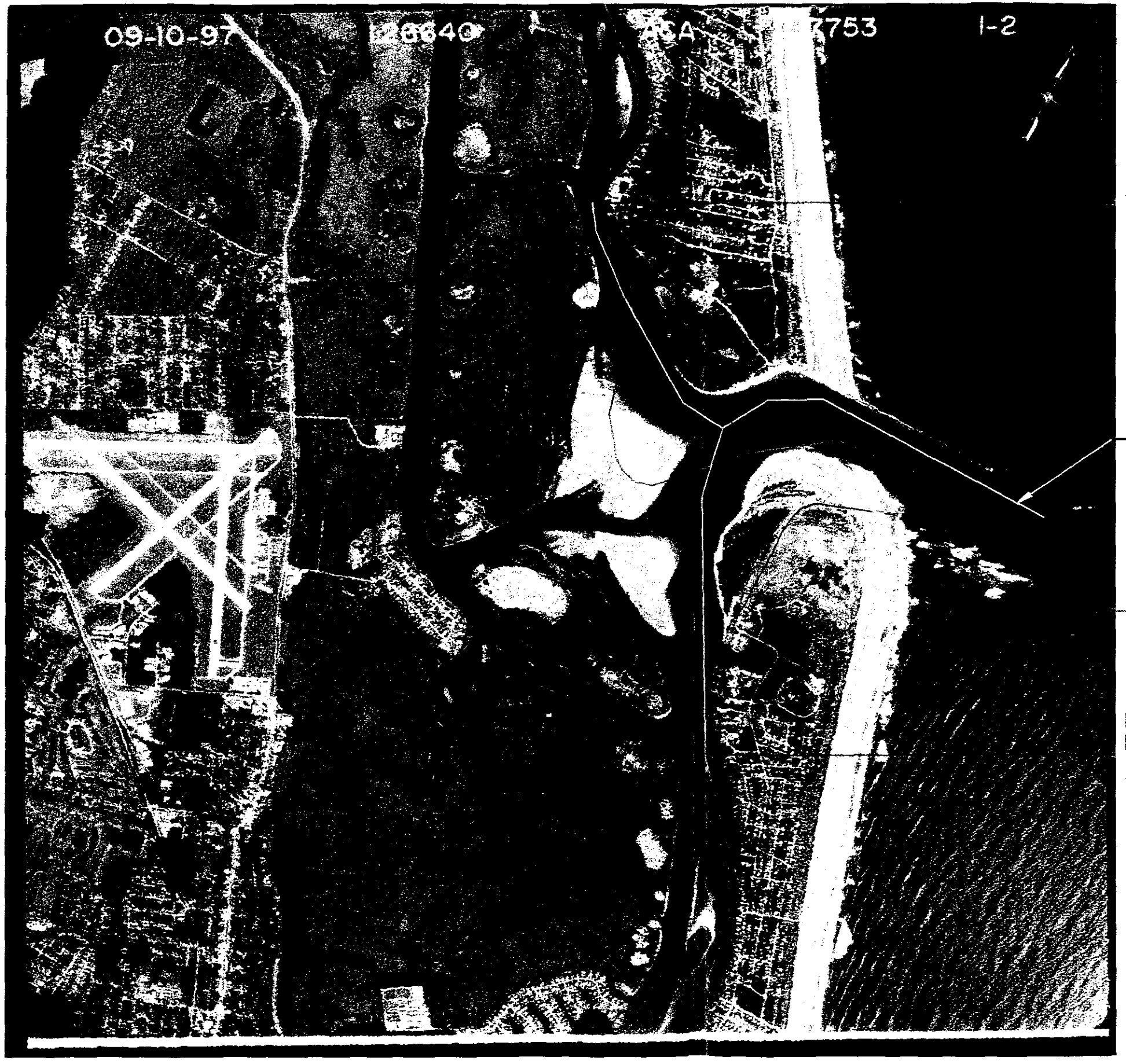
- From 1975 through 1978 the entrance channel shifted to the north and several dredging efforts made to realign it.

- Contract 78-C-0067 placed additional stone sections along the south side of the north jetty (contract for that protection was $1,485,589 as given in the FY 1979 Annual Report).

- Annual monitoring surveys of the north jetty were taken through 1985.

- Contract 81-C-0020 extended the north jetty landward for the second time to station 58+75.

- Contract 83-B-0042 provided for closure of the north jetty weir.



Reference Survey No. 98-C013,
dated March and December 1998
Project Authorized 1965
Construction Completed 1972
Weir Closed 1984

FROM THIS POINT NORTH
EXISTING DEEP WATER
APPROXIMATELY FOLLOWS
THE AUTHORIZED PROJECT

EXISTING DEEP WATER

FROM THIS POINT SOUTH
EXISTING DEEP WATER
APPROXIMATELY FOLLOWS
THE AUTHORIZED PROJECT

Ponce de Leon Inlet
Feasibility Study

Current Problems

Figure 2a

35. Due to erosion problems north of and stability in the inlet, work to close the weir occurred between October 1983 and March 1984. Since that time a number of changes have occurred in the area of the inlet. The entrance channel has migrated from its original location shown in figure 2 north toward the north jetty as shown in figure 2a. The shoreline of the spit to the west of the north jetty has receded approximately 300 to 1,000 feet while the emerging shoreline north of the south jetty has grown in a northeasterly direction as shown in figures 4 and 5. To minimize maintenance costs the connecting channels extending north and south of the inlet have been shifted with the movement of natural deep water. The 7-foot deep project to the north has shifted from its original location to a natural deep water channel with depths of 10 to 18 feet west of the north spit as in figure 3. The original 12-foot deep project to the south has shifted eastward toward naturally deep water.

36. Since completion of the project, $19,222,243 has been spent on maintenance through FY-93. At the sponsor's request in September 1994 to help prevent a potential breakthrough, approximately 215,000 cubic yards of material from maintenance dredging of the adjacent Intracoastal Waterway (IWW) Federal channel was placed along the north spit beach west of the north jetty. The north spit area provided a less expensive location for disposal of maintenance material than the normal IWW disposal area. While that contract is not settled as of this writing the contracted price was $1,000,000. That represents an average of approximately $963,000 per year through 1994. Other maintenance may be required along the landward end of the north jetty since recent site visits reveal exposure of the concrete sheetpiling. In early summer 1998 a scour apron was placed along the landward end of the north jetty and armor stone was placed to fill in slumped areas. Associated maintenance costs in 1995 and 1996 were incurred to determine the location for placement of the scour apron include $16,019 for a multi-beam sonar survey and $11,416 for a U.S. Army Diver's survey of the underwater portion of the north jetty. The bid award for the construction contract for the scour apron and additional armor stone to fill in slumped areas of the north jetty was $1,067,000. This cost does not include profit for the contractor.

Table 3

Ponce DeLeon Inlet New Work Costs and Maintenance

Since Project Completion in 1972

	NEW WORK		MAINTENANCE		
DATE	FEDERAL FUNDS	CONTRIBUTED FUNDS	FEDERAL FUNDS	CONTRIBUTED FUNDS	COMMENTS
FY-73	$ 99,298	$120,523	$ 234,704		
FY-74	$ 9,712	$ 11,822	$ 301,660		
FY-75	$ 9	$ -9	$ 1,237,000		BREAKTH[1]
FY-76	$ 0	$ 0	$ 675,299		ENT CH [2]
FY-77	$ 0	$ -172	$ 124,533		[3]
FY-78	$ 0	$ 0	$ 1,501,274	$107,000	EN CHSS[4]
FY-79	$ 0	$ 0	$ 1,136,384	$469,409	NJSTONE[5]
FY-80	$ 0	$ 37,887	$ 164,883		EMJREPR[6]
FY-81	$ 0	$ 0	$ 214,089	$ 20,629	JREPAIR[7]
FY-82	$ 0	$ 0	$ 139,086	$ 15,624	JREPAIR[8]
FY-83	$ 0	$ 0	$ 161,230		COOPSTD[9]
FY-84	$ 0	$ 0	$ 2,742,016	$ 15,624	JREPAR[10]
FY-85	$ 0	$ 0	$ 6,477,022		[11]
FY-86	$ 0	$ 0	$ 108,285		
FY-87	$ 0	$ 0	$ 140,306		
FY-88	$ 0	$ 0	$ 114,769		
FY-89	$ 0	$ 0	$ 2,801,297		DREDGE[12]
FY-90	$ 0	$ 0	$ 808,954		DREDGE[13]
FY-91	$ 0	$ 0	$ 65,656		DREDGE[14]
FY-92	$ 0	$ 0	$ 40,134		O&M Study
FY-93	$ 0	$ 0	$ 33,662		O&M Study
FY-94	$ 0	$ 0	$ 77,510		
FY-95	$ 0	$ 0	$ 47,947		See footnotes on next page.
TOTALS	$ 109,019	$170,051	$19,347,700	$628,286	

1. 139,009 cubic yards of material from entrance channel removed at a cost of $517,153. Closure of breakthrough near, and beach fill from, impoundment basin was completed August 25, 1974 at a contract cost of $582,198. E&D& S&A costs were $40,848. Hired labor surveys, inspections, and reports cost $96,801.

2. 72,515 cubic yards of material dredged from entrance channel.

3. FY-77 Annual Report not available.

4. Contract dredging of the entrance channel and south shoal was completed at a cost of $1,454,502. A contract for North Jetty Stone protection was awarded late in the fiscal year, but no costs were incurred during the fiscal year.

5. Final costs for contract dredging of the entrance channel and south shoal were $41,000. Condition and operation studies cost $30,012. A contract for North Jetty Stone protection cost $1,485,589.

6. Condition and operation studies cost $59,955. Emergency jetty repair by hired labor cost $4,097. Jetty repair by contract cost $20,659.

7. Jetty repair by contract cost $68,310. Condition and operation studies cost $59,199.

8. Condition and operation studies cost $94,252. Jetty repair by contract cost $31,009.

9. Condition and operation studies cost $84,888.

10. Maintenance of breakwaters costs $1,499,999. Dredging cost $904,989. Condition and operation studies cost $11,840. Engineering and design and supervision and administration costs were $228,304 and $96,885 respectively. Repair of the north jetty should be completed in FY-85.

11. FY-85 & 86 Annual Reports not available.

12. Repair of north jetty was completed in FY-86. A continuing contract for maintenance dredging was awarded in the amount of $2,609,099.

13. Maintenance dredging cost $671,818.

14. Repair of north jetty completed FY 1986. Authorized project depths were restored as of January 1990.

37. Inlet Changes. The extent of the northward migration of the entrance channel is shown in figure 6. Figures 4-5 indicate loss of shoreline along an area west of the north jetty and shifting of the entrance channel toward the north jetty. Figure 6 indicates the bottom of the entrance channel has shifted from approximately -23 feet MLW at a distance of 750 feet from the north jetty in 1986 to a depth of -27 feet MLW within 50-100 feet of the north jetty in 1994. Recent trips to the inlet indicate the continued erosion along the spit adjacent to the west end of the north jetty. Photograph number 13 of appendix E shows monument PDI-39 on July 8, 1992 with its concrete foundation undermined. The same monument on September 22, 1992 is shown in photograph number 15 with approximately 18 inches more of its foundation exposed. The sponsor provided photographs numbered 16 through 21 which were taken September 25, 1992. PDI-39 can be seen in the surf zone of photograph 20 as a northeaster overtops the spit area near the north jetty and threatens to create a breakthrough.

38. Safety Concerns. The United States Coast Guard (USCG) search and rescue data provided for fiscal years 1981-1991 indicates that 20 lives were lost in the area of the inlet during that period. Most of the lives lost were associated with the 109 vessels that have capsized in the inlet. In addition the records show 347 vessels ran aground. The density plot of USCG letter dated December 16, 1992, of appendix C indicates the majority of these incidents were in the area of the inlet. Appendix D contains drawings locating the approximate vessel grounding positions over aerials of the inlet. Those locations were obtained from a September 25, 1995 meeting with USCG representatives and commercial salvage boat operators at Ponce DeLeon Inlet.

39. At present to try and discourage its usage the USCG does not mark the north channel. It is considered too unstable. The USCG continues to move the channel markers along the south channel and entrance channel as conditions change in those areas. Those changes add to the time and cost associated with the operation and maintenance of navigation aids on the project.

40. Conversations with commercial and recreational vessel operators who traverse the inlet have also revealed safety concerns. Commercial shrimp vessels have outriggers that are kept down while traveling in and out of the inlet for stability. The commercial vessel operators must be very careful to avoid collisions with vessels anchored along the north jetty to fish since the deepwater channel is up against and continues to move toward the north jetty. This safety issue is expected to be of ever greater concern as the deepwater channel moves closer to the north jetty.

41. Recreational vessel operators who are not familiar with the conditions in Ponce DeLeon Inlet may expect the deepwater channel to be found in the center of the jetties. Those who have such expectations maneuver their vessels in the center and then may ground on the shoal toward the end of the entrance channel, on the south side. Sheet 3 of 6 at the end of Appendix D shows the shoal and the locations of some groundings on the shoal.

PROSPECTIVE FUTURE CONDITIONS

42. The *1991 Florida Statistical Abstract* projects the State's population growth to be between 13 and 30 percent from 1990 to the year 2000. In that same period the population in Volusia County has a projected growth of 10 to 48 percent. Since Ponce DeLeon Inlet provides the only navigable access to the Atlantic Ocean between St. Augustine (about 65 miles to the north) and Canaveral Harbor (about 57 miles to the south), use of Ponce DeLeon Inlet is likely to increase with the population.

43. With no change in the existing navigation project the anticipated usage of Ponce DeLeon Inlet would have a lesser increase than with modifications to help stabilize the inlet. The without project future condition would most likely have a usage increase of 8 to 10 percent for the inlet. A more stabilized inlet with fewer problems would be likely to produce an increase of 20 to 25 percent. Those projected increases would apply to commercial as well as the recreational use of the waterway.

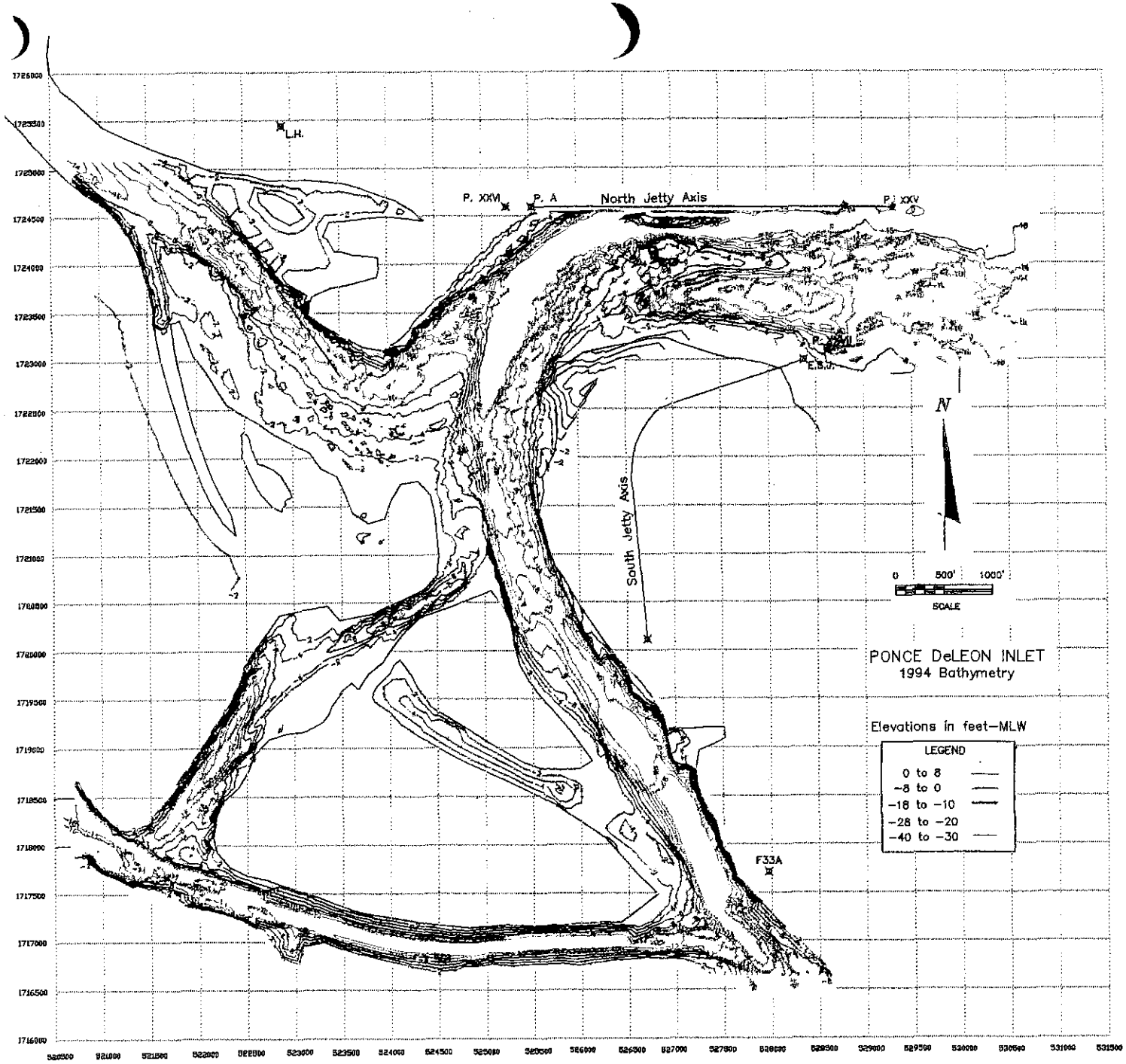


Figure 3 Contour Plot Representation of 1994 Bathymetry

Taylor Engineering, Inc. Ponce DeLeon Inlet Feasibility Study Numerical Modeling and Shoaling Analysis. Volume I. July 1996 P.2-2

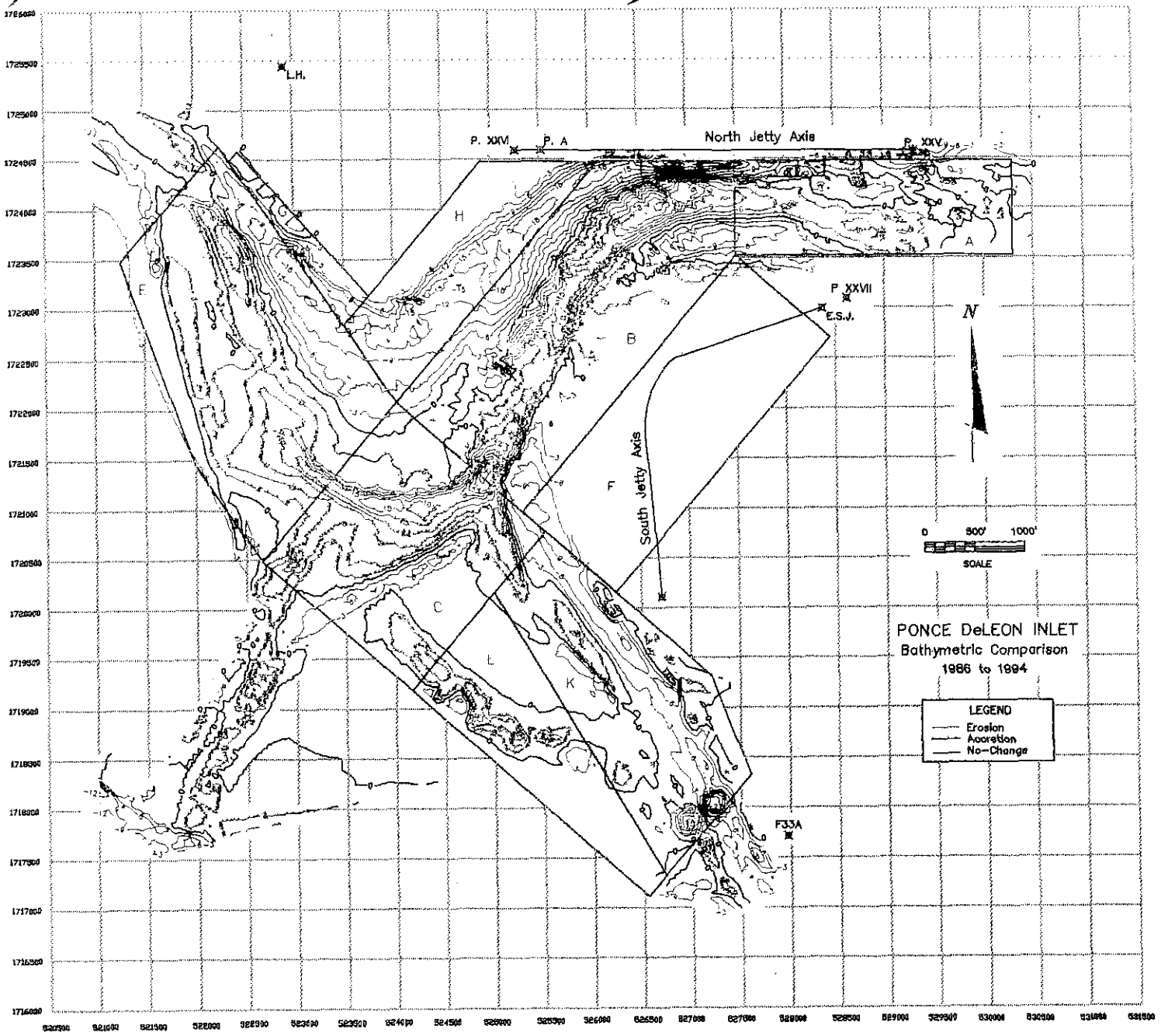


Figure 4 Changes in Inlet Interior Bathymetry, 1986 - 1994

Taylor Engineering, Inc. Ponce DeLeon Inlet Feasibility Study Numerical Modeling and Shoaling Analysis. Volume I. July 1996. P.2-7

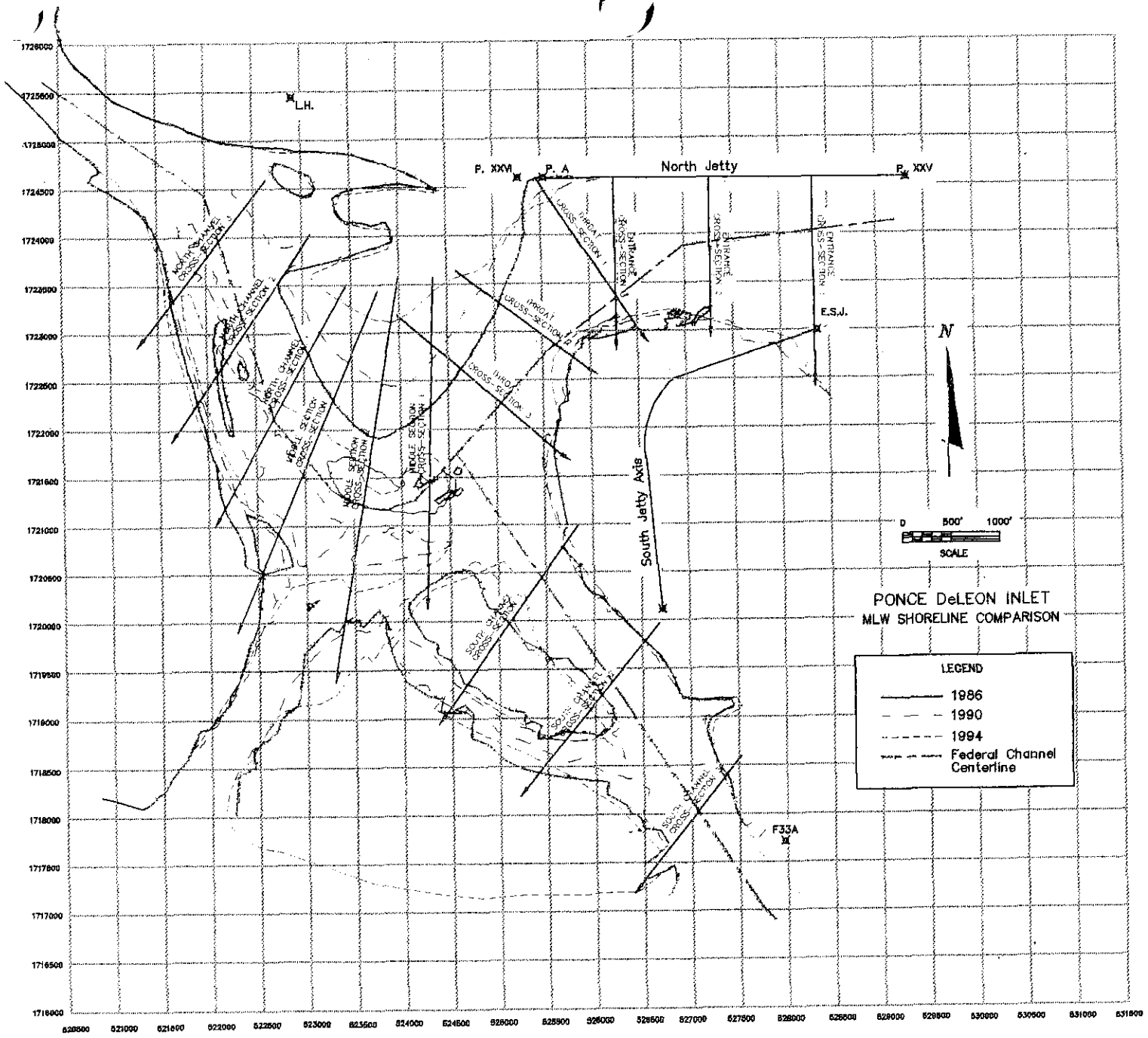
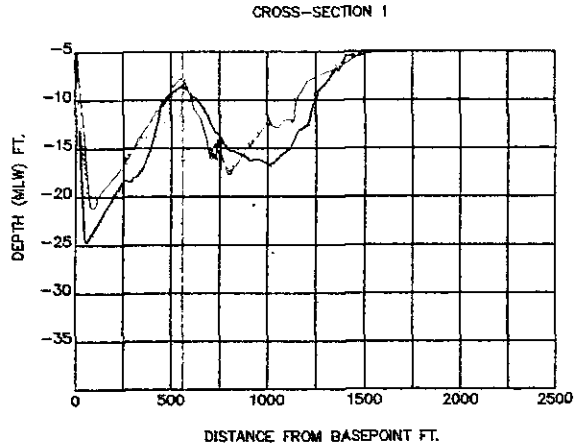
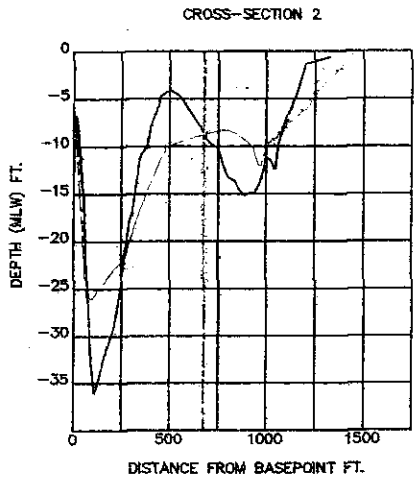


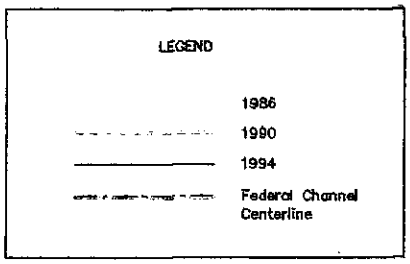
Figure 5 MLW Shoreline Comparisons - 1986, 1990, and 1994

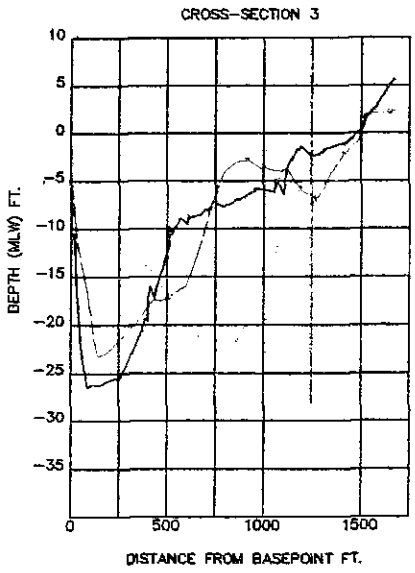
Taylor Engineering, Inc. Ponce DeLeon Inlet Feasibility Study Numerical Modeling and Shoaling Analysis. Volume I. July 1996. P2-11

ENTRANCE CHANNEL









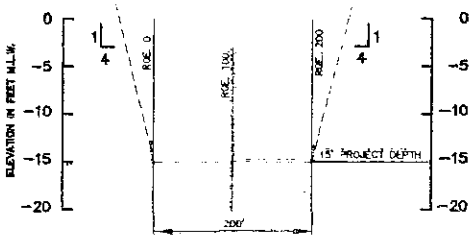


Figure 6 Entrance Channel - Comparisons of Cross Sections from 1986, 1990, 1994

44. Not only would a more stable inlet help provide a safer, more direct route for navigation to the ocean, it would help reduce future maintenance costs on the project. Assuming no improvements to help stabilize the inlet, the expectation is for erosion of the sand spit southwest of the north jetty within 8-9 years from 1994 without the occurrence of a major storm. Based on erosion rates occurring in the inlet, that projection appears very likely considering the model work completed for this study (Taylor Engineering, 1996). With the occurrence of a major storm, there is also a very real probability that a breakthrough could occur a lot sooner. Once a breakthrough happens, Federal action would likely include measures, as in the past, to block the flow through the breach and restore pre-breakthrough conditions. With no improvements in the inlet, the spit of land west of the north jetty will naturally erode until it reaches the area of the landward end of the north jetty in 8-9 years from 1994. At that time, about the year 2002, the threat of the entrance channel outflanking the north jetty will require maintenance work to extend the landward end of the north jetty to prevent outflanking.

45. A breach almost occurred during the week of September 21, 1992, when high tides combined with a northeaster resulted in intense erosion and overtopping of the spit adjacent to the north jetty (See appendix E photographs 16 through 21). Continued erosion of that area resulted in the Corps of Engineers responding to the sponsor's request to prevent a potential breakthrough by placing about 215,000 cubic yards of material in that area in September 1994 as a least cost IWW disposal option. An unexpected breakthrough is likely to duplicate the problems that occurred in February 1973. During that event the local access channel to the commercial charter/head boat facilities and boatyard on the north side of the breakthrough as well as the federal channel on the Halifax River near the breach all shoaled rapidly creating a major problem. The larger boats at those facilities did not have sufficient water to leave and other similar size boats could not gain access those facilities. With another catastrophic breach the problems faced will likely be similar.

46. Other commercial charter/head boat operators and fishermen on the Halifax River away from the immediate area of the breakthrough used an alternative route to the inlet. They traveled north along the Halifax River channel to the Intracoastal Waterway. At that point they turned south and moved along the Intracoastal Waterway to the junction with the south channel from Ponce DeLeon Inlet in Indian River. Here they turned north and traveled along the project channel to the inlet for access through the entrance channel to the ocean. The travel along the alternative route is estimated to take about 45 minutes one way. Deeper draft shrimp boats operating from New Smyrna Beach to the south would attempt to use the south channel to the entrance channel at high tide until the risk to their boats became too great. If shoaling occurred in both the north and south channels from the inlet to the extent that both channels became unusable, the closest alternative access to the ocean would be Canaveral Harbor about 57 miles to the south.

47. If quick action to close the breakthrough did not occur, a new channel would form in the breakthrough with other major changes possibly occurring in the inlet. The Lighthouse Point Park property and parking lot adjacent to the north jetty is in the erosion path of a potential outflanking. The erosion along the breakthrough route could eventually, if not immediately, result in the loss of those facilities. The north jetty could be undermined or outflanked on the west end.

ALTERNATIVE PLANS

48. The Federal objective in water and related land resources planning is to develop a plan which provides the maximum contribution to national economic development consistent with protecting the Nation's environment. In accordance with that goal, the following specific objectives apply to the navigation study for Ponce DeLeon Inlet in establishment of structural and non-structural plans:

PLANNING OBJECTIVES

49. Planning objectives for the feasibility study are the following:

- Improve the integrity of the north jetty;
- Provide a more stable system of navigation channels resulting in prevention of north jetty undermining and outflanking by the inlet channel system;
- Prevent a catastrophic breakthrough of the north spit to prevent shoaling of commercial boat access channels as well as the federal channel in the Halifax River;
- Minimize shoaling rates in the entrance channel resulting from south to north sediment transfer around the south jetty;
- Increase navigational safety of the inlet;
- Reduce maintenance costs associated with protection of the north jetty from entrance channel scouring effects;
- Minimize shoreline erosion related impacts associated with project alternatives;
- Determine the most economical construction processes for navigation improvements;
- Determine the effects of navigation improvements on overall transportation costs of commercial fishing and head boat operations;

- Consider measures and plans to minimize adverse effects on the environment and water quality during construction and maintenance of the navigation improvements;

- Identify threatened and endangered species that frequent or inhabit the area and establish means of protecting them from adverse project-related impacts;

- Identify historic properties which may be located within the area affected by proposed navigation improvements; and

- Preserve or enhance aesthetic attributes that may be disturbed by navigation improvements.

50. The formulation and preliminary analysis of alternative plans to achieve planning objectives were based on the Water Resources Council's Principles and Guidelines, the National Environmental Policy Act of 1969, and related Corps regulations. These guidelines provide for developing alternative resource management systems that address planning objectives.

CONSTRAINTS

51. During the process of plan formulation and selection, certain constraints must be a consideration in the evaluations to arrive at the planning objectives:

- Plan selection must be consistent with local planning for land use and area development;

- Selection of a plan must not negatively impact the shoreline ten miles to the north or south of the inlet;

- Plan selected must be feasible to construct and enable safe movement of vessels to serve existing and future commerce and traffic;

- Tangible national economic development (NED) benefits must exceed economic project costs on an average annual equivalent (AAEQ) basis or net present worth basis for plan justification;

- Plan with the maximum net benefits (largest increment of benefits over or above costs) is designated the NED plan;

- Plan must protect significant historic properties as well as endangered species of wildlife and marine habitat; and

- Plan implementation must satisfy State and Federal water quality standards.

CONSIDERED MEASURES FOR INLET STABILIZATION

52. In the development of alternative structural and non-structural plans certain navigation features were a consideration:

- Various length extensions and orientations of the south jetty;
- Reopening the north jetty weir to various lengths;
- Realignment of the entrance channel by construction of a channel through the north spit overlying the past historical breakthrough location;
- Construction of a groin field along the sand spit inside the inlet and adjacent to the north jetty spit; and
- Landward extension of the north jetty in conjunction with a revetment along the north sand spit.

53. Combinations of the above measures for stabilizing the inlet resulted in an array of plans for improvement to the navigation project. The development of those plans is summarized in the subsequent paragraphs and discussed in appendix A.

PRELIMINARY ASSESSMENT

54. On starting the feasibility study after completion of the reconnaissance phase, initial work involved assembling the numerical and physical model study team to review data gathering requirements. Bathymetric surveys of the study area including bank to bank coverage of the interior channels, an ebb shoal survey, shoreline surveys of the north and south beaches combined with aerials of the study area provided a baseline of existing conditions for the model work. To help establish the profile of the north jetty a centerline survey was performed.

55. Data Gathering for Model Work. In addition to the bathymetric surveys a SHOALS (Scanning Hydrographic Operational Airborne Lidar Survey) survey of the inlet provided even greater detail. The SHOALS hydrographic survey provided detailed bathymetry for both the physical and numerical models. Other information gathered for calibration of the modeling effort included current and tide data. Appendix A contains details of the entire data gathering process in combination with the supplemental report of this document.

56. Review of Measures to Stabilize Inlet. Completion of survey work enabled a preliminary assessment of existing conditions. Shoreline surveys of the throat of the inlet revealed that the sand spit west of the north jetty (Figure 5) had eroded quicker than expected. Placement of a groin field in that area to protect the land that was remaining was no longer a practical approach. A significant portion of the spit had already been removed and the erosional process was projected to continue before action to protect it could occur. Of the original 80 acres purchased in 1986 by the State of Florida and the Port Authority, 40 acres had eroded by 1992. Of the remaining 40 acres owned by the State of Florida only an estimated 22 acres existed in 1994.

57. Groin Field. Under existing conditions the hydrodynamics of the inlet continue to severely erode the spit as shown in figure 5. With the revised shoreline and the orientation of the entrance channel and Halifax River channel to the north eroding the north spit from the east and northwest sides, groin fields would no longer provide an effective measure in stopping erosion. If actually put in place the accelerated erosion from the west and east sides of the spit could leave the groins detached. In addition to being ineffective in protecting the shoreline the detached groin field would negatively impact navigation. The natural rapid recession of the north spit shoreline does not allow installation of a groin field in a timely manner. As a result of the north spit's rapid recession rate, the groin field was removed from discussion as a measure to help stabilize the inlet.

NUMERICAL/PHYSICAL MODEL TESTING

58. Other measures received additional consideration in light of the surveys received. A large scour hole along the entrance channel side of the north jetty with depths of 30 to over 40 feet confirmed the continued migration of the entrance channel up against the north jetty. The 30- to 40-foot depths are located within 50 feet of the north jetty (figure 6). To relieve the hydraulic pressure on the north jetty and help stabilize shifting navigation channels, the following measures were considered in more detail for model testing.

59. Alternative Measures for Model Testing. Other study goals in addition to relieving the hydraulic pressure on the north jetty addressed by the model testing program involve:

- Improve integrity of the north jetty;
- Provide a more stable system of navigation channels;
- Increase navigational safety of the inlet; and
- Prevent a catastrophic breakthrough of the north spit.

60. The study team met with representatives from the Coastal And Hydraulics Laboratory (CHL) of the Waterways Experiment Station in Vicksburg, Mississippi and Taylor Engineering of Jacksonville, Florida, a consultant for the study sponsor, to discuss study goals. A hybrid model testing program was developed that included a physical model developed by CHL combined with a numerical model from Taylor Engineering to evaluate measures to stabilize the inlet.

61. Beginning with the previously mentioned initial meeting of the study team and modelers to review data gathering requirements for the model work, a test program was developed to review measures to stabilize the inlet. Over a series of meetings from 3 June 1994 involving a review of data gathering needs through 31 August 1995 the following model testing program developed. The supplemental report to this document contains calibration information and other details of the model testing program.

62. South Jetty Extension. As suggested during the Reconnaissance Review Conference and by the Feasibility Cost Sharing Agreement, testing of an extension of the south jetty should occur in combination with other measures to stabilize the inlet. As a result, the numerical and physical model test plan centered on studying different orientations and lengths of the south jetty first. Jetty lengths of 500, 800, and 1,000 feet received evaluation along two different orientations. One consisted of a straight extension along the centerline of the existing south jetty. The other extended parallel to the north jetty as shown in figure 7. An optimum orientation and length was desired for the south jetty extension before adding other measures to the test program.

63. The objective of model testing different orientations and lengths of the south jetty involved determining the degree to which each option improved hydrodynamic conditions and decreased sediment transport potential into the inlet. Both the numerical and physical models indicated that a 1,000-foot extension fulfilled study goals the best. Dye and coal tracer tests in the physical model revealed the 1,000-foot jetty extension parallel to the north jetty would be needed as the most effective alternative in reducing northward sediment transport around the tip of the jetty without adversely impacting navigation in the inlet. Physical model results were inconclusive in determining the most effective orientation. The numerical model clearly identified that the 1,000-foot south jetty extension parallel to the north jetty would provide the most improved hydraulic conditions for the outer portions of the inlet channel. This alternative was found to provide a more uniform flow distribution across the width of the inlet as well as smaller increases in velocities. It provided an added benefit in that it lowered some of the hydraulic pressure along the south side of the north jetty distributing the flow more uniformly across the inlet.

64. From a surfer's perspective, model results show that the 1,000-foot extension of the south jetty parallel to the north jetty should improve wave conditions. The physical model indicated that during ebb normal flow wave heights in the surfing area south of the south jetty increased by an average of about 10%. During flood tide there was no change in the average wave height.

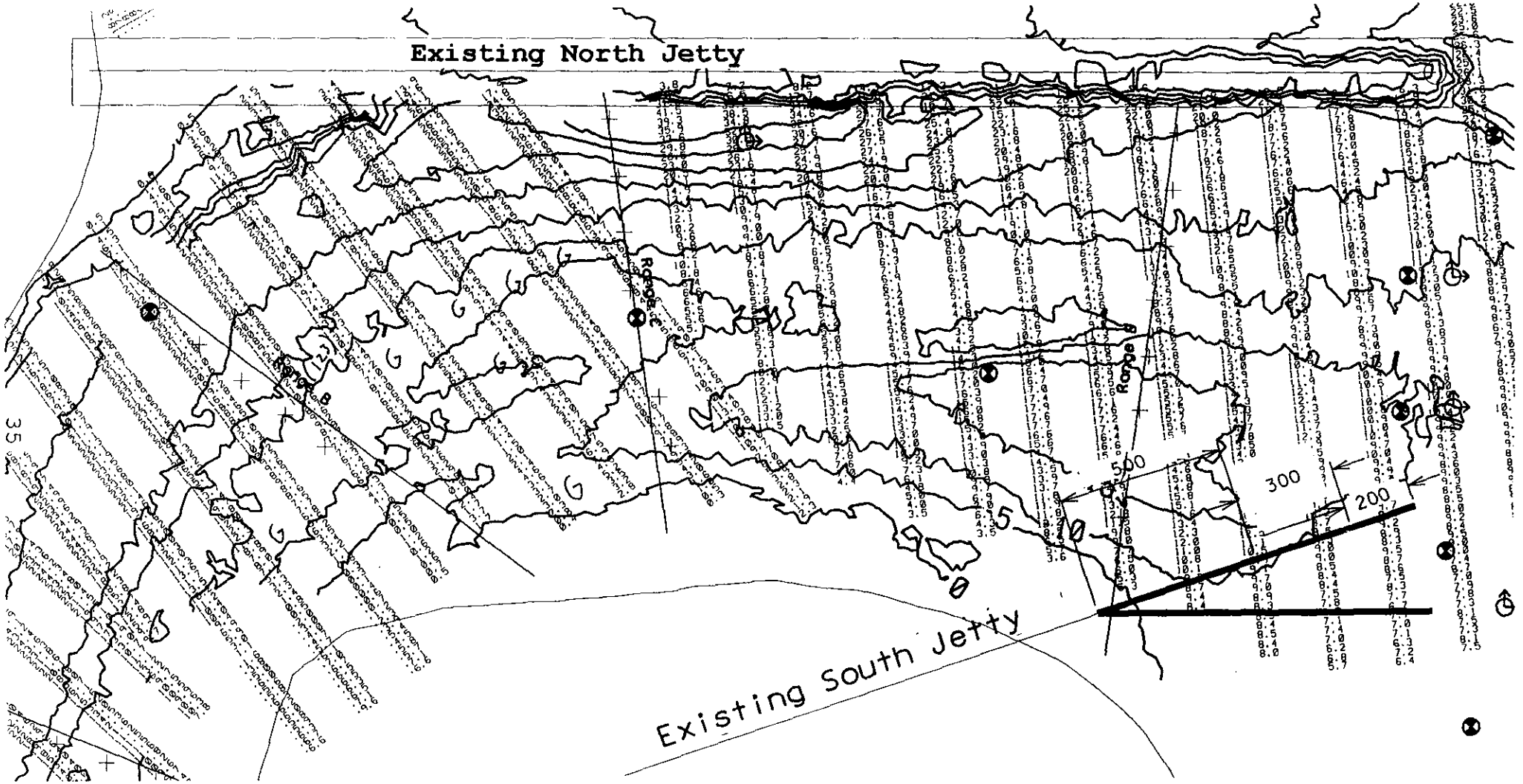


FIGURE 7 (SOUTH JETTY EXTENSION LENGTHS AND ORIENTATIONS)

65. For the remaining test program, the 1,000-foot extension of the south jetty parallel to the north jetty was used in combination with the other measures. Both the reopening of the north jetty weir and dredging of a channel through the north spit were tested with the 1,000-foot extension of the south jetty parallel to the north jetty.

66. North Jetty Weir Opening Options. The model testing program examined 500, 1,000 and 1,540-foot openings of the north jetty weir starting from the seaward end of the original weir opening and extending landward as shown in figure 8. Those openings were tested in combination with a 1,000-foot extension of the south jetty parallel to the north jetty. The objective of examining various weir openings included determining the optimum weir length to ease scour pressure along the north jetty and spit while not adversely impacting navigation. Wave and current conditions during physical model testing of the north jetty weir openings provided insight relative to sediment transport potential and wave energy overtopping the weir which adversely impacts navigation.

67. Numerical model results indicate re-opening the weir in the north jetty would produce minimal positive impacts on the hydraulic processes of Ponce DeLeon Inlet. Some localized changes in velocities might occur near the weir in the existing channel but not in the center or entrance portions of the inlet. Physical model tests provided similar results. Dye and coal tracer tests revealed that none of the weir openings improved flows near the center of the inlet. The physical model revealed limited increase in sediment transport potential in the vicinity of the weir. Wave heights within the inlet under all weir openings tested showed an increase over existing conditions.

68. Physical and numerical model tests confirmed that none of the weir openings improved conditions in the inlet. Migration of the channel up against the north jetty has resulted in a scour hole that continues to deepen with depths of over 48 feet and a length of approximately 500 feet. The continued natural straightening and deepening of the entrance channel along with the reorientation of the throat of the inlet (Halifax and Indian River channels) evidently entrains too much water for a mean low water weir to effect an ebb dominated flow. The Sponsor notes that as the sand spit west of the north jetty continues to erode, vessel operators enjoy the resulting deeper-than-normal Halifax River channel depths. The authorized Federal channel in the Halifax River has a project depth of seven feet and a bottom width of 100 feet. Surveys dated September 1994 and October 1995 confirm that depths varying from seven to over fifteen feet and spanning widths of over 300 feet exist in the Halifax River channel west and north of the north jetty sand spit.

69. Opening the weir would allow a supply of sand into the inlet. However, results indicated that currents south of the weir are strong and can move material out of the area. That area would not function well as an impoundment basin since it is located along an area of the entrance channel with excessively high current velocities. For the most part, sediment passing over the weir in that area would not deposit in an impoundment basin as planned. A portion would settle in existing shallow areas of the inlet.

70. Opening the weir increased the amount of wave energy inside the inlet. Although wave heights were below the safe navigation limits discussed in the physical model report of appendix A, they were about twice as large as when the weir was closed. The direction of wave approach (across the weir) and any crosscurrents through the weir would further increase the difficulty of navigating through the inlet. For those reasons the study team agreed at CHL on February 6, 1996 that reopening the weir was not considered a viable measure. In addition the physical model report concludes that the benefits of opening the weir are far outweighed by the negative impacts on navigation and sediment accretion within the inlet.

71. Channel Realignment. Testing a realignment of the entrance and Halifax River channels through the north spit involved use of the numerical model. During a 30-31 August 1995 meeting at CHL, study team members in consultation with CHL, Taylor Engineering, SAD, and sponsor representatives agreed the numerical model provided a more flexible vehicle for testing channel realignment than the physical model. The old Halifax River channel (the location to which the existing channel is most likely to migrate) provided a location for the realigned channel configuration. An October 1944 Condition After Maintenance Dredging Survey provided the location of the old channel along with a survey of the breakthrough area in May 1973. The February 1973 breakthrough location shown on the May 1973 survey occurred in the area of the old Halifax River channel.

72. For model testing of channel realignment, a 200-foot wide by 12-foot deep channel was used as shown in figure 9. Numerical model tests indicated that the island, a remnant of the north spit, created by the channel would continue to erode from both the west and east sides. During a flood flow velocities of 5 feet per second are estimated to attack the east side of the island. Velocities of 7 feet per second were predicted at the west side of the island on an ebb flow (See figures 7.57 and 7.58 of the Taylor Engineering Volume II Report). Before a state of equilibrium is reached with the new channel, deposition of that material could occur at the back of the inlet throat and along the existing deep water channel of the Halifax River. Navigational depths along the Halifax River channel to the north could be impacted. Other impacts to navigation could occur as the shoal at the back of the inlet throat builds and extends eastward toward the Indian River channel. The numerical model shows adequate depths for navigation would prevail for most vessels in both channels once a quasi-equilibrium condition is reached. During the time it takes the inlet system to get to that point negative navigation impacts are likely to occur.

73. Due to the high erosion rates expected on the west and east sides of the island created by the engineered channel, the possibility for shoaling exists along the Federal channels in the Halifax River to the north and the Indian River to the south. With the realigned channel, revetment along the north shore of the alignment is required to keep the ebb and flood flows within the design channel and prevent the new channel from eroding that shoreline and outflanking the north jetty. Straightening of the entrance

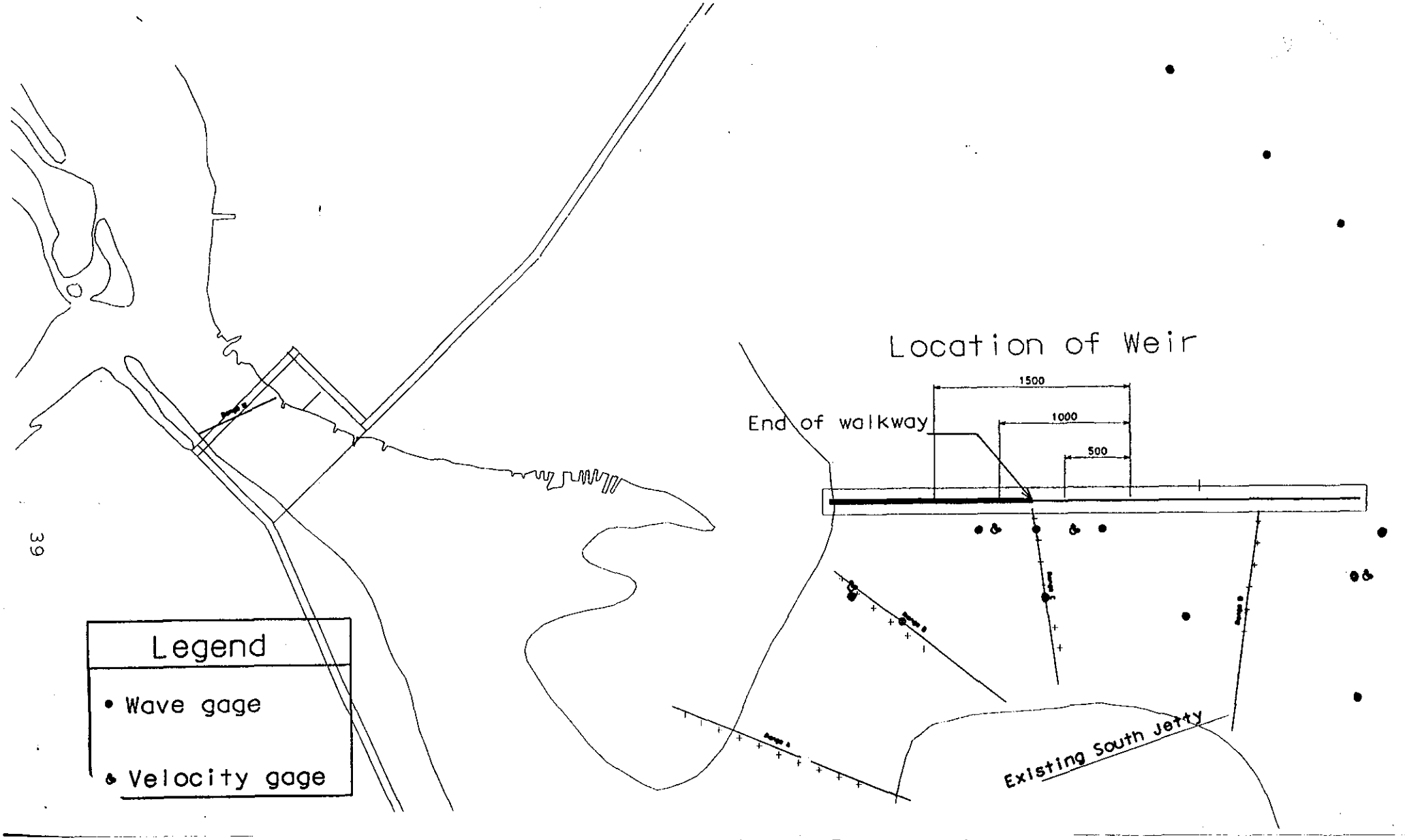


FIGURE 8 (NORTH JETTY WEIR OPENING LENGTHS)

channel, however, would reduce scouring and relieve hydraulic pressure on the north jetty.

74. Channel realignment as a measure to stabilize the inlet is kept for further consideration.

OTHER MEASURES

75. Other measures for providing a more stable and safe inlet included two different revetment alternatives. During the Reconnaissance Study three different revetment alignments received consideration. Figure 10 shows the location of each alignment in relation to the north spit and jetty. Alignment one provided shore protection for the entire north spit area as it existed at that time. Alignments two and three protected other upland/wetland areas closer to the main shoreline of the inlet. All three revetments would tie into the landward end of the north jetty.

76. As mentioned earlier more recent surveys (July 1994) of the inlet revealed that approximately 75 percent of the area that would have been protected by revetment alignment one had eroded since that aerial photograph was taken. Figure 5 also provides a comparison of shoreline changes from 1986-1994. Most of the north spit eroded before it could be protected. For that reason, alignment three or some variation of it would not be practical due to the accelerated erosion rate of the north spit. Before a revetment could be designed and built to protect that area, it would erode past the planned alignment. Alignment three assumes the entire north spit erodes and only protects the north jetty from outflanking. Commercial charter boats and salvage boats located behind and to the west of the remaining spit would no longer receive protection from waves and currents. Since alignment three only meets one of the study goals, it was not considered further in the feasibility study.

77. Alignment two protects approximately nine acres of upland and wetland areas. Approximately 6.6 acres of that nine acre protected area are wetlands. While the revetment covers about 2.1 acres of wetlands, a net 4.5 acres (6.6-2.1) of wetlands are protected. It also provides protection from currents and waves for the commercial boatyard and marina located behind and west of that area. Further investigation during the feasibility study resulted in development of two different segments of the revetment along alignment two as shown in figure 11.

78. 800-Foot Landward Extension of the North Jetty. The first segment of that revetment along alignment two is an 800-foot landward extension of the north jetty to the west. That portion of the revetment is designed with stones the same size as the north jetty. For design details see appendix A. The 800-foot landward extension of the north jetty is considered an operations and maintenance measure.

79. That portion of the revetment will require construction with or without a project due to the continuing erosion of the north sand spit. A recession analysis indicates that under current conditions the north spit will erode to the area of the armor alignment in approximately eight to nine years from 1994 (Taylor Engineering, 1996). Figure 5 identifies the rapid erosion of the north spit from 1986 to 1994. By the year 2002 an 800-foot extension is required to prevent outflanking of the north jetty. To protect the integrity of the north jetty Operation and Maintenance plans should include construction of the 800-foot extension prior to or not later than the year 2002.

80. The 800-foot extension of the north jetty is the minimum required to effectively tie back the landward end far enough west to prevent outflanking from both the flood and ebb currents converging in that area. Figures 3.1 through 3.3 of Volume I of the Taylor Engineering study provide a look at the anticipated bathymetry, erosion, and shorelines in the expected breakthrough area as compared to 1994 bathymetry and shoreline data. An examination of those figures reveals about a 1,000-foot section from the west end of the north jetty to an old Halifax River channel which requires protection to prevent outflanking.

81. 1,540-Foot Revetment. As shown in figure 11 a 1,540-foot revetment extends from the end of the 800-foot landward extension of the north jetty along a portion of the north spit. The footprint of the revetment follows what remains of the north bank of an old Halifax River channel. The old river channel is also the location of the 1973 breakthrough and a current area of concern during times of high water associated with a northeaster. That portion of the revetment prevents currents and waves from eroding the remaining upland/wetland areas of the north spit. Erosion of the north spit must be stopped at the alignment of the 1,540-foot revetment to prevent current and wave action from impacting the boatyard and marina behind and to the west of that area. Figures 12 and 13 provide views of the commercial vessel operations protected by the revetment. Portions of Lighthouse Park could also be subject to erosive current and wave action if erosion of the north spit was not prevented by a revetment in that area. The 1,540-foot revetment also adds to the effectiveness of the 800-foot landward extension of the north jetty in preventing outflanking of the north jetty.

82. Model testing of the 1,000-foot extension of the south jetty indicated the shift in velocities away from the north jetty only occurred within the area of the entrance channel. No changes to currents at the throat of the inlet occurred as shown in figures 7.5 and 7.6 of the Volume II Taylor Engineering Report. For that reason the 1,540-foot revetment measure is needed to prevent further current and wave action from impacting the commercial vessel operations behind the remaining portion of the north spit as well as an enhancement to prevention of outflanking of the north jetty. For those reasons the 1,540-foot revetment is a non-separable element and is considered an integral part of any plan to stabilize the inlet system.

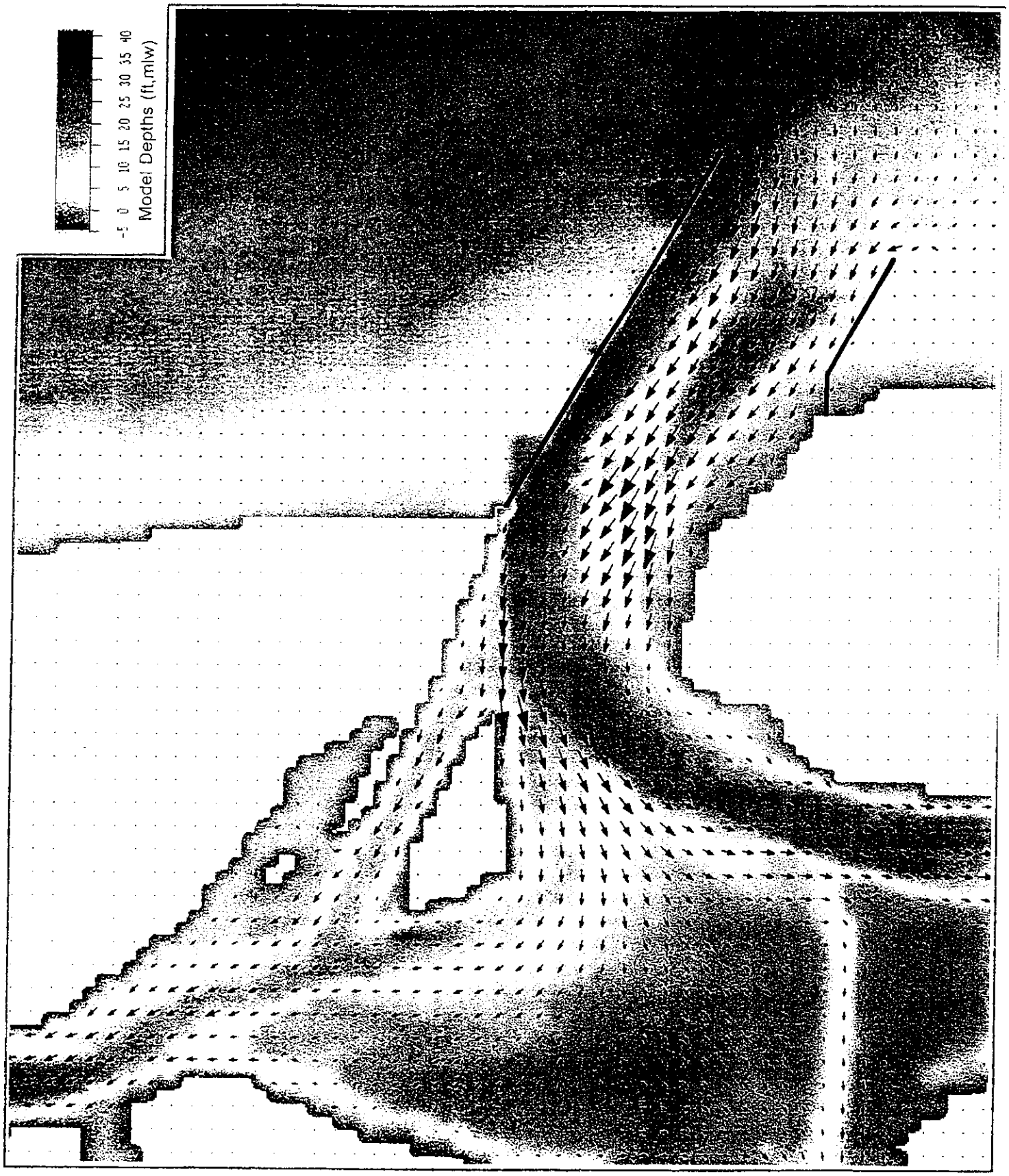


FIGURE 9 (CHANNEL REALIGNMENT)

Flood Velocity Vectors for Engineered Channel, Initial Conditions (Case 3)
Taylor Engineering, Inc.

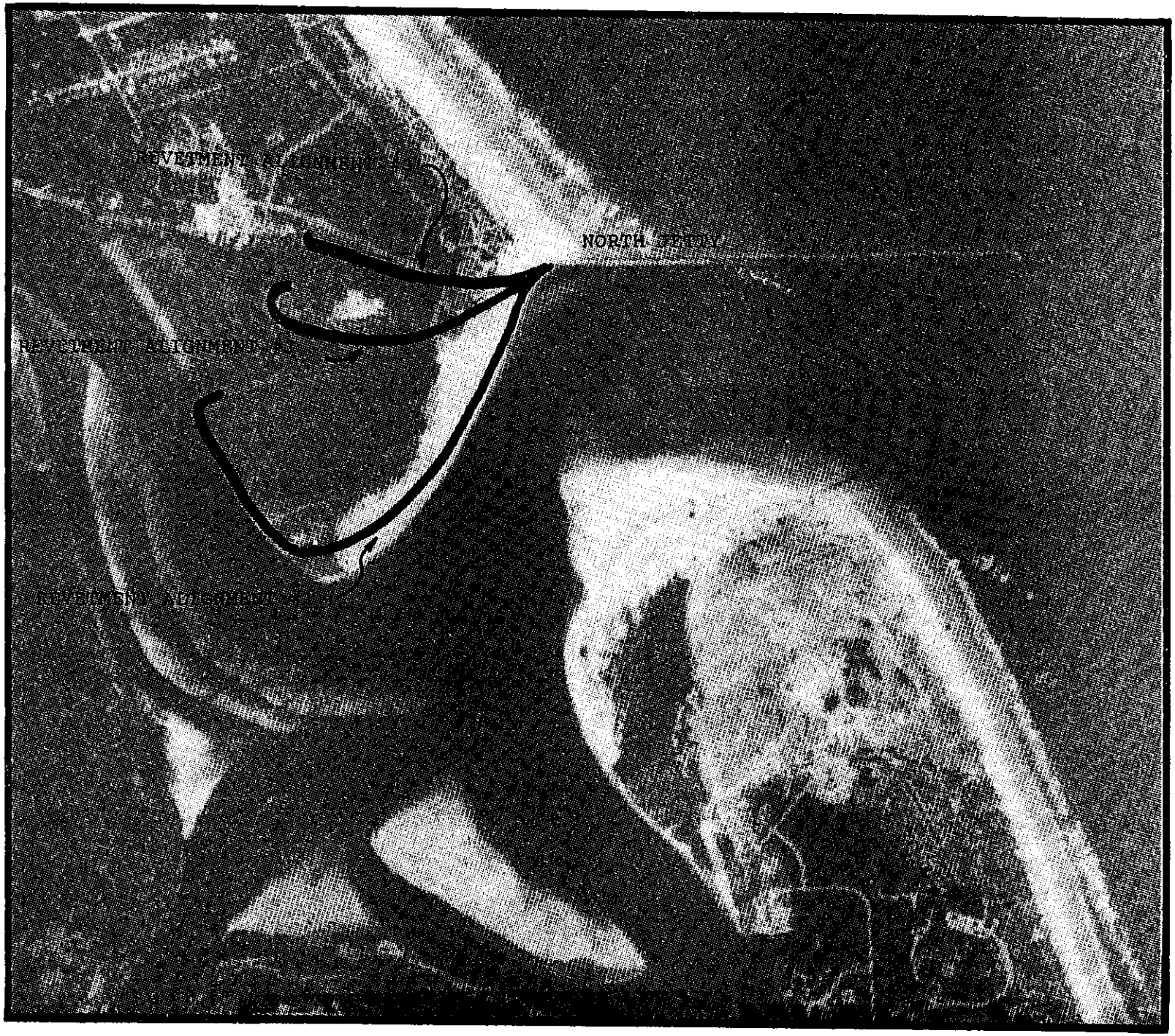


FIGURE 10 (REVETMENT ALIGNMENTS)


Deep Water Channel
Revetment Alignment
Limits of Construction
1540-foot revetment
(O&M work)
800-foot extens
(O&M work
Tie into Existing Jetty
Centerline of Existing North Jetty
Deep Water Channel
POINCE DE LEON INLET
Deep Water Channel
Eastern Limit of
Existing South Jetty
Centerline of
South Jetty Extension
(Plan A - Selected Plan
Ponce de Leon Inlet
Feasibility Study
Figure 11

NO ACTION PLAN

83. No Action Plan (Without Project Condition). If no action is taken, the most probable future conditions for the inlet without further project modifications would involve the following:

84. Catastrophic Channel Breakthrough of the Old Halifax River Channel. The formation of another channel will likely cause a change in flow conditions with shoaling occurring in some areas. The resulting shallower depths will probably necessitate emergency maintenance work as they have in the past. This future condition could be worse than those previously experienced. The weir was open at that time causing an influence on channel flow vectors in the area of the breakthrough. With the weir closed on a flood tide the forces will be greater at the point of the breakthrough.

85. Once a breach occurs, past experience indicates the altered hydrodynamics within the inlet would cause rapid shoaling in certain areas for the short to intermediate term. That shoaling would likely close the water access to the marinas and boatyard on the north side of the expected breakthrough. Shoaling is a likely probability in the Halifax River portion of the Federal channel near the breakthrough. The Federal Halifax River channel would likely be temporarily unusable for ocean access and boaters would attempt to use other access routes via the Intracoastal Waterway (IWW) to the southern channel in Indian River or farther south to Canaveral Harbor. That condition would last until Federal maintenance work could block the breach and remove shoals. A total shoaling volume of approximately 230,000 cubic yards will result (Taylor Engineering, 1996, page 3-3).

86. Estimated erosion rates along the shoreline of the spit west of the north jetty are about 70 to 80 feet a year. At that rate the next breakthrough is possible before the year 2000 without the occurrence of a major storm. The force of such a storm could cause a breakthrough sooner. Site visits after storm activity late in 1992 indicate historical conditions support the engineering estimates. The area had experienced minor overtopping and the erosion rate had apparently increased during the event. Again in 1994 storm activity resulted in overtopping of the north spit and the start of a breakthrough in that same area. To prevent an actual breakthrough from occurring and threatening the landward end of the north jetty the Corps of Engineers used maintenance material from a section of the IWW near Rockhouse Creek. Approximately 215,000 cubic yards of material was placed from the landward end of the north jetty to the area of the past breakthrough from April through September 1994.

87. Numerical modeling of a catastrophic breach condition as shown in figures 3.1 and 3.3 of Volume I of the Taylor Engineering report, "Ponce DeLeon Inlet Feasibility Study Numerical Modeling and Shoaling Analysis", indicates controlling depths in the breakthrough area of six feet with maximum depths of 12 feet. Shoaling in the north channel results in depths of about four feet. A total shoaling volume of approximately

230,000 cubic yards will occur (Taylor Engineering, 1996, page 3-3). Depending on the shoreline erosion rate and extent of fill material to close the breach in the spit and restore the shoreline in that area, the occurrence of a breakthrough will likely occur again and be cyclical.

88. North Jetty Stability. Conditions at the inlet threaten the stability of the north jetty. A deep water channel is very close to the jetty with existing depths ranging from 30 feet to nearly 50 feet. The scour apron installed on the south side of the jetty for protection was with channel depths at 20 feet or less. Prevailing velocities in the entrance channel have been sufficient to erode a deeper channel which may now be below the protective scour apron in places. A 1994 survey showed depths of 30-40 feet along a section of the north jetty with a significant portion approaching 40 feet as shown in figure 3. A more recent survey by U.S. Army Divers from June 3-15 of 1996 along the length of the north jetty indicates depths of over 48 feet in the area of the scour hole. The exposed sand in vulnerable areas along the jetty is subject to erosion. The scour apron constructed in 1979 is still mostly intact and is providing adequate protection to the jetty. The deep scour hole observed at the north jetty occurs along an area which begins immediately landward of the 1979 scour apron. In July 1998 construction of a scour apron along the scour hole area was completed; this apron extends from the western limit of the 1979 scour apron to the eastern limit of the scour apron on the 800-foot landward extension of the jetty. The entire length of the north jetty is then protected against scouring damages. Portions of the north jetty crest have already slumped 3 feet or more since initial construction. Continued maintenance costs are likely to be high for repair work to maintain the integrity of the existing jetty structure.

89. Erosion of Spit Adjacent to North Jetty (With Maintenance). The State of Florida and the port authority in 1986 purchased about 40 acres, shown in appendix E photograph number 24, as part of the Lighthouse Point Park. As indicated on the photograph, a portion of that area, marked "GONE", has eroded since the purchase. Erosion of the shoreline in that area will continue until there is a breakthrough. As a temporary preventative measure, material from maintenance work has been placed along the eastern side of the spit in the past. As mentioned in paragraph (a) above about 215,000 cubic yards was placed from the landward end of the north jetty to the area of the breakthrough in April through September 1994. That material still may not be enough in the event of a major storm to prevent a breakthrough. A public park building had to be moved from its original location south of the parking lot to an area north of the parking lot when erosion of the north spit threatened to undermine its foundation in 1994. The area also had to be marked as dangerous and unsafe for the public due to a high scarp and strong currents.

FIGURE 12 (NORTH SPIT AND COMMERCIAL VESSEL FACILITIES)

FIGURE 13 (COMMERCIAL VESSEL REPAIR AND CHARTER OPERATIONS)

90. Outflanking of the North Jetty. Once a breach begins, the public park building and parking lot could be lost in the ensuing erosion from high velocities in the developing channel flow. The channel erosion could also cause the loss of material from outflanking on the west end of the north jetty. Emergency maintenance would be necessary to try and minimize the damage impacts. Damage to the west end of the jetty with its concrete walkway is possible if measures to stop erosion do not occur in time. Continued outflanking of the west end of the north jetty could produce an entire new outlet for the Halifax and Indian Rivers resulting in major changes to the inlet. Shoaling of both the north and south channels as well as changes in entrance channel would result making passage through the inlet extremely dangerous and unpredictable.

91. Natural Erosion of the North Spit (Without Maintenance-Allowing a Breakthrough). Under normal conditions without a major storm event the north spit will continue to erode. If dredged material is not placed along the north spit to prevent a breakthrough, the north spit will continue to erode from the east and west sides until it is eroded away to the area of an old Halifax River channel. During that gradual process the material eroded from the north spit will continue to build up islands at the back of the inlet throat on either side of Rockhouse Creek as shown in figure 7.73, Volume II of the 1996 Taylor Engineering Report. The Federal navigation channels which currently follow the area of deepest existing water are expected to continue to provide adequate depths for navigation. In the spring and summer of 1996 the sponsor indicates regular users of the Federal channel in the Halifax River to the north of the inlet report deeper water than has existed in recent times. That trend is expected to continue with a natural erosion of the north spit. Eventually over the long term depths of 10 to 12 feet will develop in the area of the old Halifax River channel (implied from numerical modeling of that condition as shown in figures 7.93 and 7.94 of the Taylor Engineering Report Volume II).

92. A review of the above measures in relation to the study goals of providing a more stable and safe inlet for navigation and reduction of ongoing operation and maintenance produced the need to combine some of the measures. The combination of various measures to form new alternative plans satisfied study goals better than individual measures.

93. As mentioned earlier, hydrodynamic model testing of the 1,000-foot jetty extension by itself and in combination with reopening the north jetty weir and a channel realignment narrowed the field of measures to consider. Model tests showed that the 1,000-foot jetty extension by itself produced desirable results for the outer portion of the inlet. Some study goals were met by combining it with a channel realignment. Reopening the north jetty weir in combination with the 1,000-foot jetty extension did not satisfy major goals of shifting the entrance channel away from the north jetty and improving navigation. A combination of the above measures resulted in the following plans.

COMBINING MEASURES

94. Plan A - South Jetty Extension. Both physical and numerical model results indicate that a 1,000-foot extension of the south jetty parallel to the north jetty provides the best hydrodynamic improvements to the inlet of the two different orientations and three different lengths tested (i.e. six alternatives examined). Figure 11 shows the location of the jetty extension in relation to the existing south jetty. The physical model indicated the potential for the greatest reduction in sediment transport into the inlet from that alternative. The numerical model confirmed the velocities and flows with that alternative increased the least. The smaller the velocity changes the lesser the impact on increasing wave heights relating to navigation concerns. In addition to wave height, wave steepness is a concern. In Ponce DeLeon Inlet, in the entrance channel, wave steepness is a safety issue. On the ebb flow, incoming waves hit outgoing currents, slowing wave velocities and compressing waves. The waves are therefore steeper. Extending the jetty would decrease the heights of waves entering the inlet, especially waves coming from southerly directions, because the jetty extension will block the waves. Conditions will be safer as a result, particularly during ebb flow. Potential for a natural relocation of the federal channel toward the center of the inlet also exists. As a result Plan A is carried forward for further review in combination with other measures.

95. Plan B - North Jetty Weir Opening. Plan B involves reopening the north jetty weir from the seaward end of the original opening landward for lengths of 500, 1,000, and 1,500 feet in combination with Plan A. Both physical and numerical model testing of Plan B indicates that none of those north jetty weir openings satisfies study goals. Numerical model results of flow and velocity distribution comparisons showed for the most part very little change in comparison to existing conditions. Some localized changes in velocities occurred near the weir in the existing channel but not in the center or entrance portions of the channel. Physical model dye and coal tracer tests revealed that none of the openings improved flows near the center of the inlet. The model revealed a limited increase in sediment transport potential in the vicinity of the weir. Wave heights within the inlet under all weir openings tested showed an increase over existing conditions. The physical model confirmed findings of the numerical model that no beneficial results for stabilizing the inlet and improving navigational safety accrued. Therefore, Plan B is not considered any further.

96. Plan C - Channel Realignment. Plan C involves a realignment of the entrance channel with the Federal channel in the Halifax River to the north of the inlet as shown in figure 9 in combination with Plan A. An engineered cut through the north sand spit provides a 12-foot deep by 200-foot wide channel 2000 feet long. The dredged channel requires removal of approximately 193,000 cubic yards of material. Approximately 50 percent of that material is beach quality and would be placed within a 2000-foot reach on the beach north of the north jetty. Model tests indicate high erosion rates expected on the west and east sides of the island created by the engineered channel resulting in shoaling to the south of the channel and closure of the existing north channel which hugs the spit with the engineered channel eventually becoming

dominant (Taylor Engineering, 1996, Vol. 2, pp. 7-149 and 7-155). The possibility for shoaling along the Halifax River channel to the north and the Indian River channel to the south while the inlet adjusts to that change seems to outweigh the benefits of straightening out the entrance channel with the realignment. With the realigned channel, revetment along the north shore of the alignment is a likely requirement to keep the ebb and flood flows within the design channel and prevent the new channel from eroding that shoreline and outflanking the north jetty. Straightening of the entrance channel would reduce scouring and relieve hydraulic pressure on the north jetty. Plan C is not kept for further consideration since that area is expected to establish a channel through natural processes.

97. Plan D - Groin Field. The groin field described in figure 14 received consideration early in the feasibility study. Approximately 75 percent of the area shown in that illustration has been degraded. Under existing conditions the ebb and flood tidal currents continue to severely erode the spit. With the revised shoreline and the orientation of the entrance channel and Halifax River channel to the north eroding the north spit from the east and west sides, groin fields would no longer provide an effective measure in stopping erosion. If actually put in place the accelerated erosion from the west and east sides of the spit could leave the groins detached. In addition to being ineffective in protecting the shoreline the detached groin field would negatively impact navigation. As a result of the shoreline survey analysis the groin field was removed from discussion as a measure to help stabilize the inlet. During a Plan Formulation and Engineering Technical Review Conference at the Jacksonville District on July 12, 1995, the sponsor, District, and SAD personnel agreed on removal of the groin fields from further consideration.

98. Plan E - Landward North Jetty Extension (Maintenance). As mentioned earlier three landward north jetty extension alignments existed during the Reconnaissance Study for consideration as shown in figure 10. Due to the dynamics of the inlet, erosion of the north spit occurred before any action to provide a landward extension of the north jetty in the area of alignment one could occur. Figure 5 illustrates the rapid shoreline recession. Alignment three does not provide any protection for the remaining areas of Lighthouse Point Park nor the commercial vessel marinas in the area. Alignment two provides protection for those areas as well as preventing the north jetty from being outflanked. Plan E as shown in figure 11 consists of a 800-foot landward extension of the north jetty along alignment two. Appendix A contains engineering design and construction details.

99. Plan E is a maintenance requirement that requires construction with or without the project. An analysis of the north spit erosion indicates that the entire area will continue to erode back to the Plan E alignment by the year 2002 with or without improvements (Taylor Engineering, 1996, Vol. 1, p. 3-7). Plan E must exist by the year 2002 to prevent outflanking of the north jetty. Continued outflanking of the west end of the north jetty could produce a entire new outlet for the Halifax and Indian Rivers resulting in major changes to the inlet. Shoaling of both the north and south channels as well as

changes in entrance channel would result making passage through the inlet extremely dangerous and unpredictable.

100. Plan F - Revetment. As shown in figure 11 Plan F consists of a 1,540-foot revetment extending from the end of the 800-foot landward extension of the north jetty (Plan E) along the north shoreline of an old Halifax River channel. As mentioned earlier model testing of the 1,000-foot extension of the south jetty indicated a shift in velocities away from the north jetty only occurred within the area of the entrance channel. No changes to currents at the throat of the inlet occurred as shown in figures 7.5 and 7.6 of Volume II of the 1996 Taylor Engineering Report. For that reason the 1,540-foot revetment measure is needed to prevent further current and wave action from impacting the commercial vessel operations behind the remaining portion of the north spit as well as an enhancement to prevent the outflanking of the north jetty.

101. Plan F also protects approximately nine acres of upland/wetland areas from erosion. Approximately 6.6 acres of that nine acre protected area are wetlands. Placement of stone or other shoreline hardening material is expected to provide a net 4.5 acre (6.6-2.1) savings of wetlands when compared to the without project condition which results in a loss of all the existing wetlands/uplands located west of the north jetty.

102. Appendix A contains an engineering and design analysis of revetment design for Plans A and F (Design of Revetment Section #2). Plan F is considered a non-separable element in combination with Plan A. Both are needed together to satisfy study goals. Plan A is the best alternative for reducing sediment transport around the south jetty and helps shift currents away from the north jetty and toward the center of the inlet. However, model testing shows that no change in currents occur at the throat with Plan A so erosion of the north spit will continue without a revetment along the alignment of plan F to stop it (Taylor Engineering, 1996, Vol. II, p. 9-2).

103. Plan G - South Channel Extension. Plan G extends the existing south channel northward along the Intracoastal Waterway (IWW) to a planned commercial fishing park facility located at the former Swoope Power Plant site shown in figures 15-18. The channel extension provides access for deeper draft commercial fishing vessels to potential new docking, fish processing, and repair facilities. The channel extension involves deepening of only the 12-foot by 125-foot wide IWW portion since existing deep water is available with a channel realignment of the current south Ponce DeLeon Inlet channel. The existing 125-foot width of the IWW is kept. Depths considered for the evaluation included 1-foot increments from 13 to 22 feet. Quantities for each depth are in Table 4.

104. The same numerical, two-dimensional hydrodynamic model and companion sediment transport methodology used earlier was modified to test plan G channel deepening on three different inlet conditions. The conditions included existing 1994 inlet bathymetry, an expected future inlet bathymetry (channel through the inlet's north

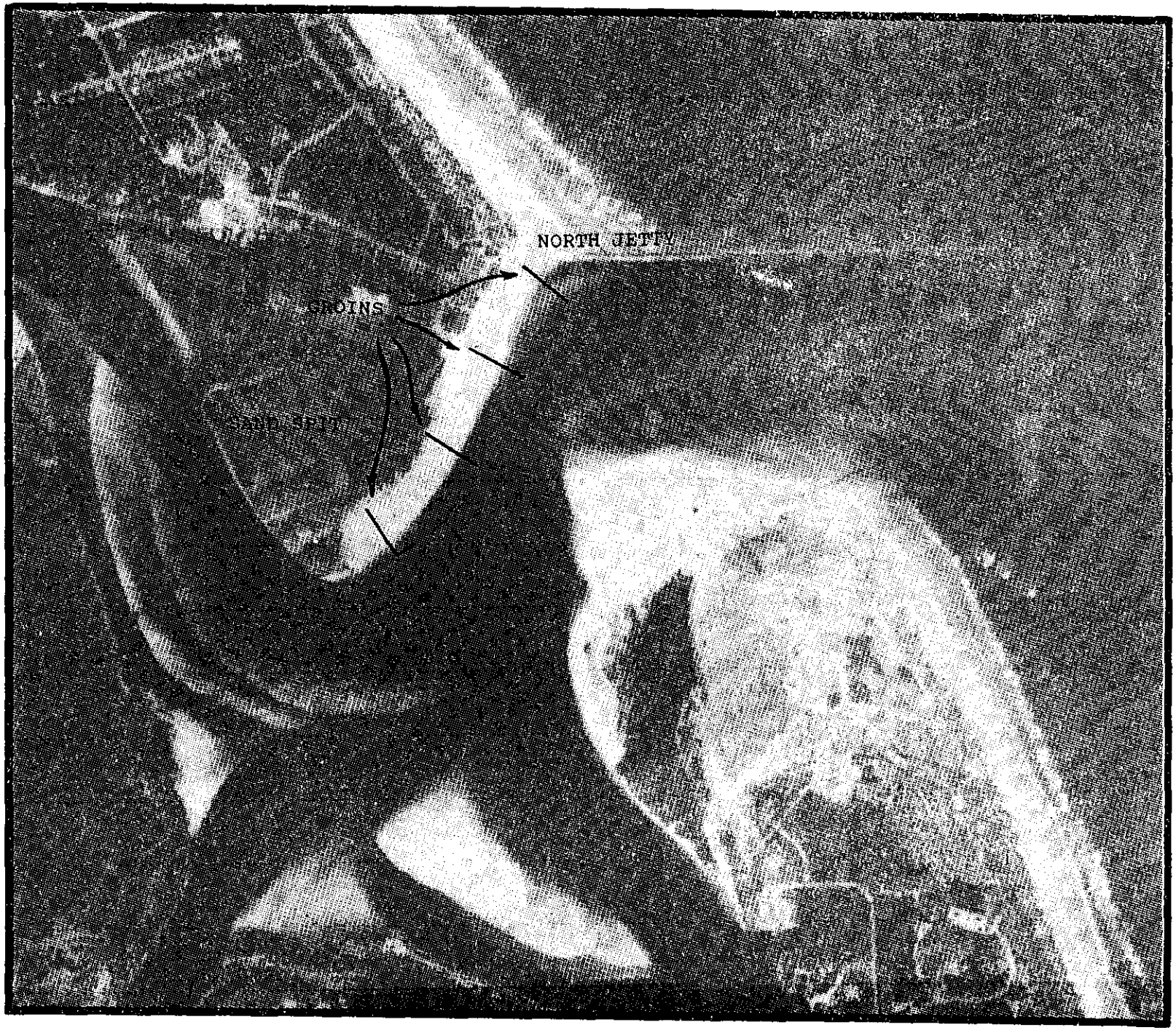


FIGURE 14 (GROIN FIELD)

spit with a submerged shoal), and an alternative future inlet bathymetry (channel through the north spit with an emergent island). Each of the three conditions contained the proposed 1,000-foot south jetty extension.

Table 4
Deepening Volumes

Depth (feet)	Volume (cubic yards)				
	IWW	Proposed fish processing facility (berthing areas)			Total
	Cuts V-24 to V-27	Side channel	Adjacent to Cut V-24	Subtotal	
13	40,856	27,353	19,993	47,346	88,202
14	79,374	29,095	24,467	53,562	132,936
15	127,635	30,836	28,941	59,777	187,412
16	183,624	32,578	33,415	65,993	249,617
17	256,785	34,319	37,890	72,209	328,994
18	323,087	36,060	42,365	78,425	401,512
19	404,702	37,801	46,840	84,641	489,343
20	492,558	39,542	51,315	90,857	583,415
21	585,327	41,283	55,790	97,073	682,400
22	682,945	43,024	60,265	103,289	786,234

105. The model testing revealed minimal hydrodynamic and sediment transport impacts for all three inlet conditions. Changes in velocities within the deepened IWW cuts ranged from 0.02-0.04 feet per second during both flood and ebb. According to Taylor Engineering, operating under the limitations of the present sediment transport methodology, existing sedimentation/erosion regimes are expected to be largely unaffected by the proposed deepening of the IWW (Taylor Engineering, 1997, pp. 60-62).

106. After a public workshop on July 24, 1997, sponsored by the Volusia County Council Port Authority Advisory Board, three additional locations for the commercial fishing park facility were considered. Plan G reviewed a total of four different sites for that facility. In addition to the Swoope Power Plant location, Feger's Seafood fish processing facility in the City of New Smyrna Beach, a marine industrial zoned site adjacent to the Boston Whaler Plant south of New Smyrna, and an existing location for commercial fishing charter vessels and repair facilities located on the north side of the inlet by the lighthouse represent other alternative locations. The existing Ponce DeLeon Inlet commercial charter fishing/repair facilities on the north side of the inlet are limited for expansion by the adjacent Lighthouse Point Park, Lighthouse Museum, and the Town of Ponce Inlet. Access to commercial highways such as U.S. 1 requires traveling north about 5.5 miles to the Port Orange bridge over various types of roads. Some of those roads are not currently designed for commercial traffic. Due to the limited room for expansion and inadequate commercial transportation access, the

existing commercial fishing and repair facilities on the north side of the inlet near Lighthouse Point Park were dropped from further consideration.

107. A comparison of the costs to deepen the existing IWW to the other three locations is shown in Table 5. For each of the depths shown the Swoope Power Plant options are less than the cost to deepen the Federal IWW channel to either the Feger or the Boston Whaler sites.

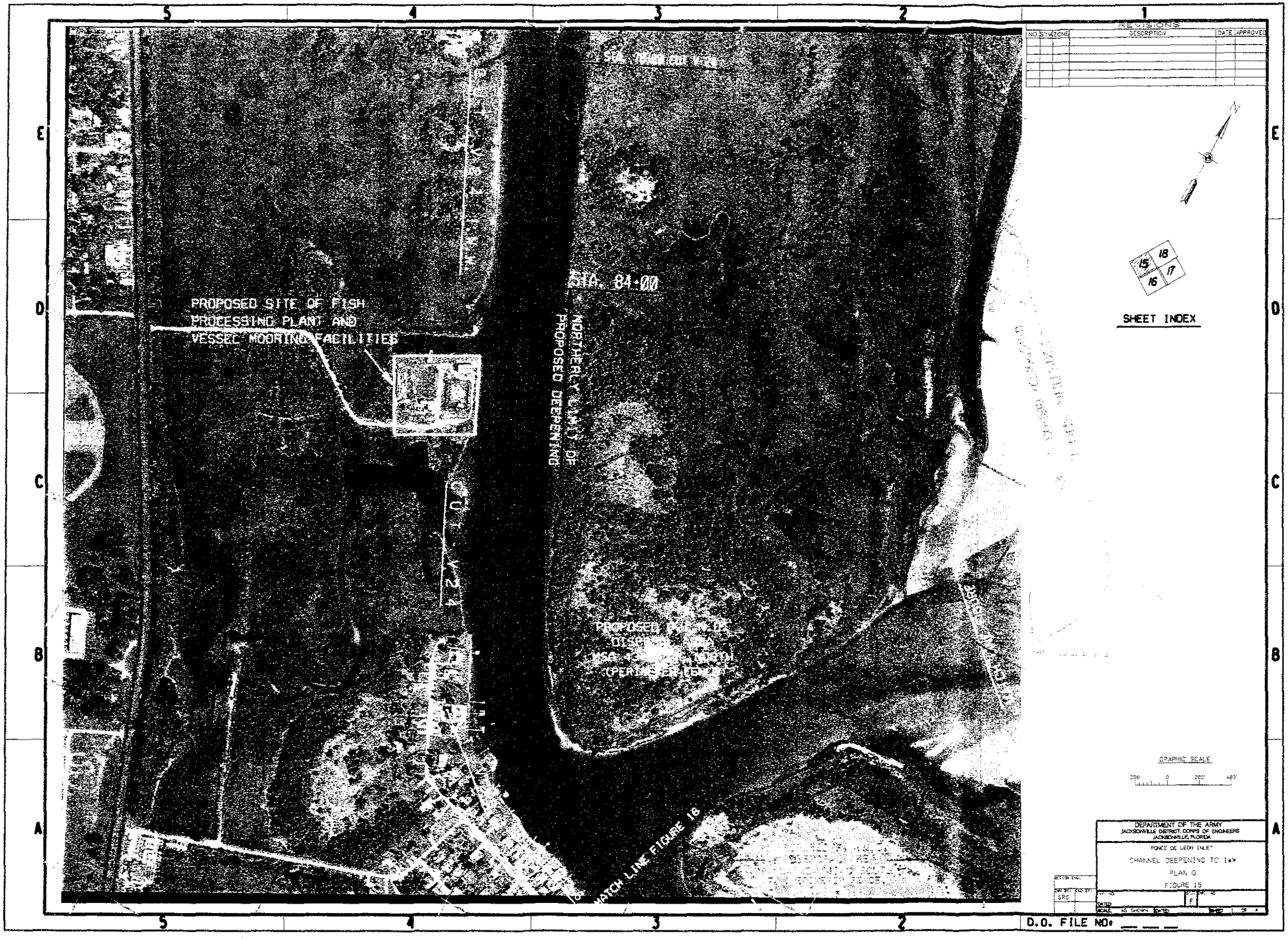
Table 5

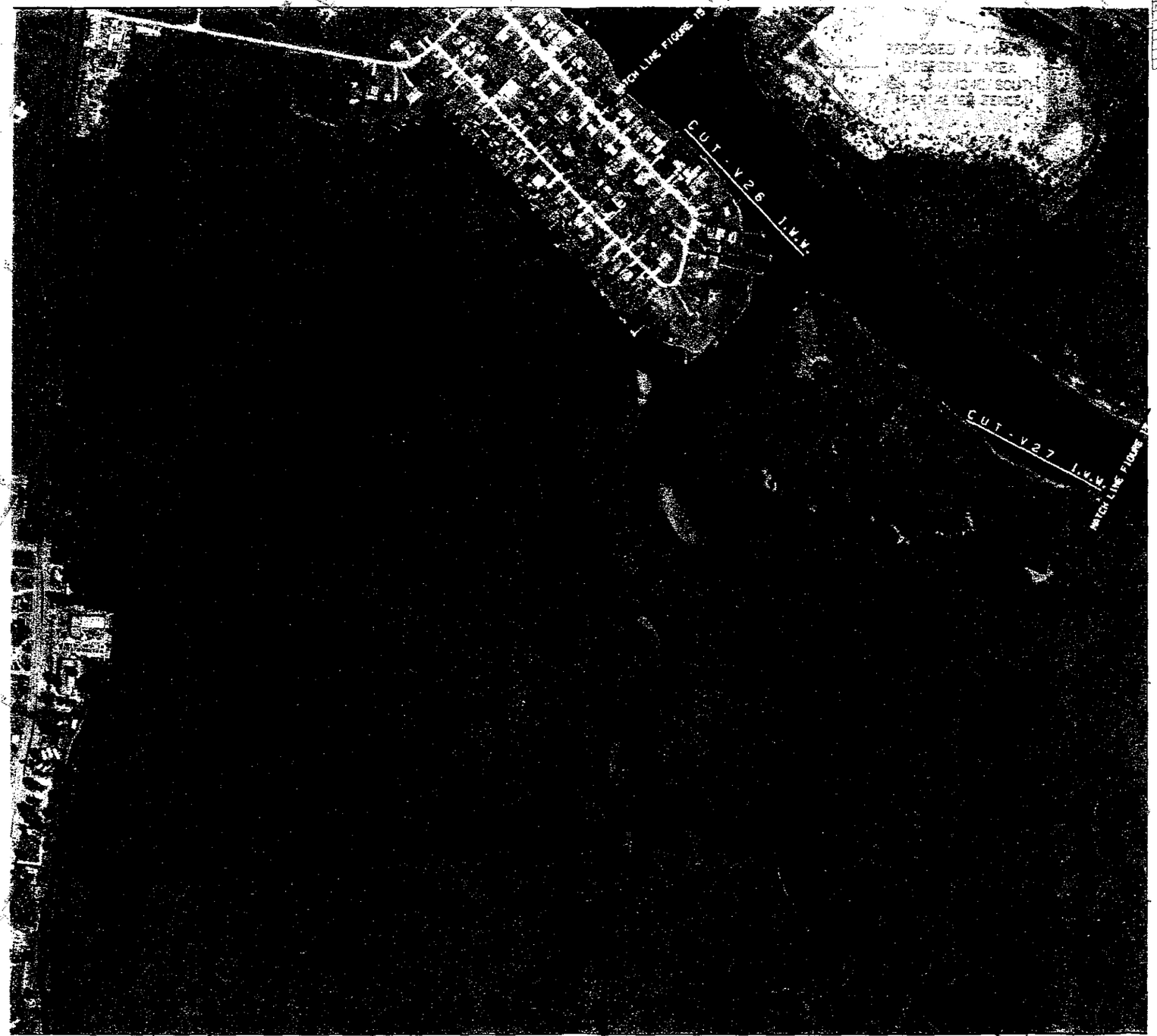
Plan G Fishing Park Locations/ Disposal Options

Locations/Disposal Options	14' Depth	15' Depth	16' Depth
Swoope Power Plant Site			
South Beach 1 (OP)	$2,096,000	$2,426,000	$2,756,000
South Beach 2 (Revised Access)	$1,572,000	$1,803,000	$2,042,000
Upland MSA 434/434C N&S	$1,349,000	$1,550,000	$1,740,000
Shoals - Inlet Throat	$1,269,000	$1,467,000	$1,662,000
Feger Site (MSA 434/434C N&S)	$2,505,000	$2,736,000	$2,877,000
Boston Whaler Site (V-26/V-21)	$9,548,000	$10,801,000	$11,772,000

108. The disposal areas considered for each of the above plan G alternatives include current IWW disposal sites for dredged material from the section of the IWW containing that particular alternative. For example, according to the current disposal plan for the IWW, the Swoope Power Plant and Feger's are located in Reach IV of the IWW. The primary site for disposal of material from that reach is a beach placement area located south of Ponce DeLeon Inlet and designated as Beach Placement Area V-PDI. The secondary site for Reach IV is an upland disposal area called MSA 434/434C North and South (Taylor Engineering, 1997). The Boston Whaler Plant alternative is located in Reach V of the IWW. The primary disposal sites for that reach include V-26 and V-21 (Taylor Engineering).

109. Of the four disposal options shown for the Swoope Power Plant, the least expensive location is listed as Shoals-Inlet Throat and shown on figures 15, 17, and 18. That disposal option consists of open water discharge of material on existing shoals located at the back of the inlet throat on each side of Rockhouse Creek. Controlling the discharge of dredge material onto those existing shoals may prove difficult. Dredged material might flow into the adjacent Federal navigation channels resulting in a shoaling problem. U.S. Fish and Wildlife Service also considers the shoal areas as the least favorable of all the potential disposal areas since those areas provide feeding sites for shore and wading birds. For those reasons no further consideration of that alternative was made. With that option eliminated, Table 5 indicates the resulting least cost disposal option is an upland disposal area called MSA 434/434C North and South.


PROPOSED SITE OF FISH
PROCESSING PLANT AND
VESSEL MOORING FACILITIES
STA. 84+00
PROPOSED DEEPENING
NORTHERLY LIMIT OF
TO MATCH LINE FIGURE 16
REVISIONS
NO. SYMBOL
DESCRIPTION
DATE
APPROVED
15
18
16
17
SHEET INDEX
GRAPHIC SCALE
200 0 200' 400'
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA
PONCE DE LEON INLET
CHANNEL DEEPENING TO 14'
PLAN G
FIGURE 15
DESIGN SUPV.
DRAWN BY
SRC
CHKD BY
SUPV.
DATE
SCALE AS SHOWN
SHEET
OF
D.O. FILE NO.



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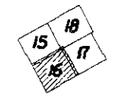


SHEET INDEX

GRAPHIC SCALE

200' 0 200' 400'

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

PONCE DE LEON INLET

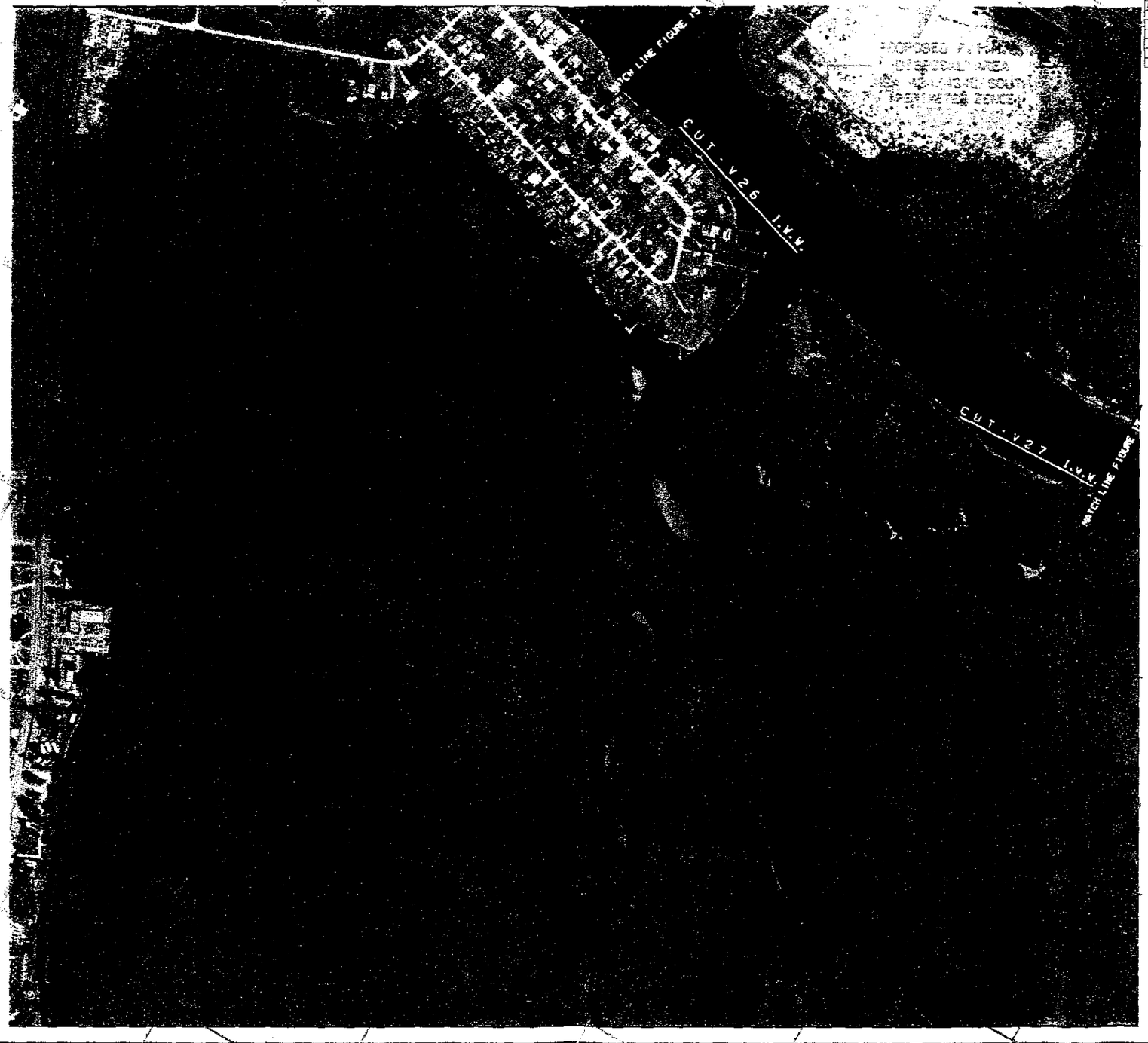
CHANNEL DEEPENING TO INW

PLAN 6

FIGURE 16

DESIGNED
DRAWN
SRC
TRACED
CHECKED
QUANTITIES
SCALE AS SHOWN DATUM
SHEET 4 OF 4

D.O. FILE NO: ___ ___ ___



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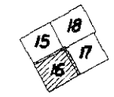
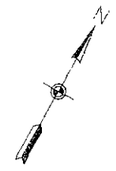


SHEET INDEX



GRAPHIC SCALE

200' 0 200' 400'

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

PONCE DE LEON INLET
CHANNEL DEEPENING TO IWW
PLAN O
FIGURE 15

SECTION END:
DRN BY: SRC CHK BY:
TWP. NO.
RANGE NO.
F
DATED:
SCALE AS SHOWN DATED
SHEET 2 OF 4

D.O. FILE NO:

REVISIONS

NO. SYM	ZONE	DESCRIPTION	DATE	APPROVED

15 18
16 17

SHEET INDEX

GRAPHIC SCALE

200' 0 200' 400'

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

PONCE DE LEON INLET

CHANNEL DEEPENING TO 13'W

PLAN G

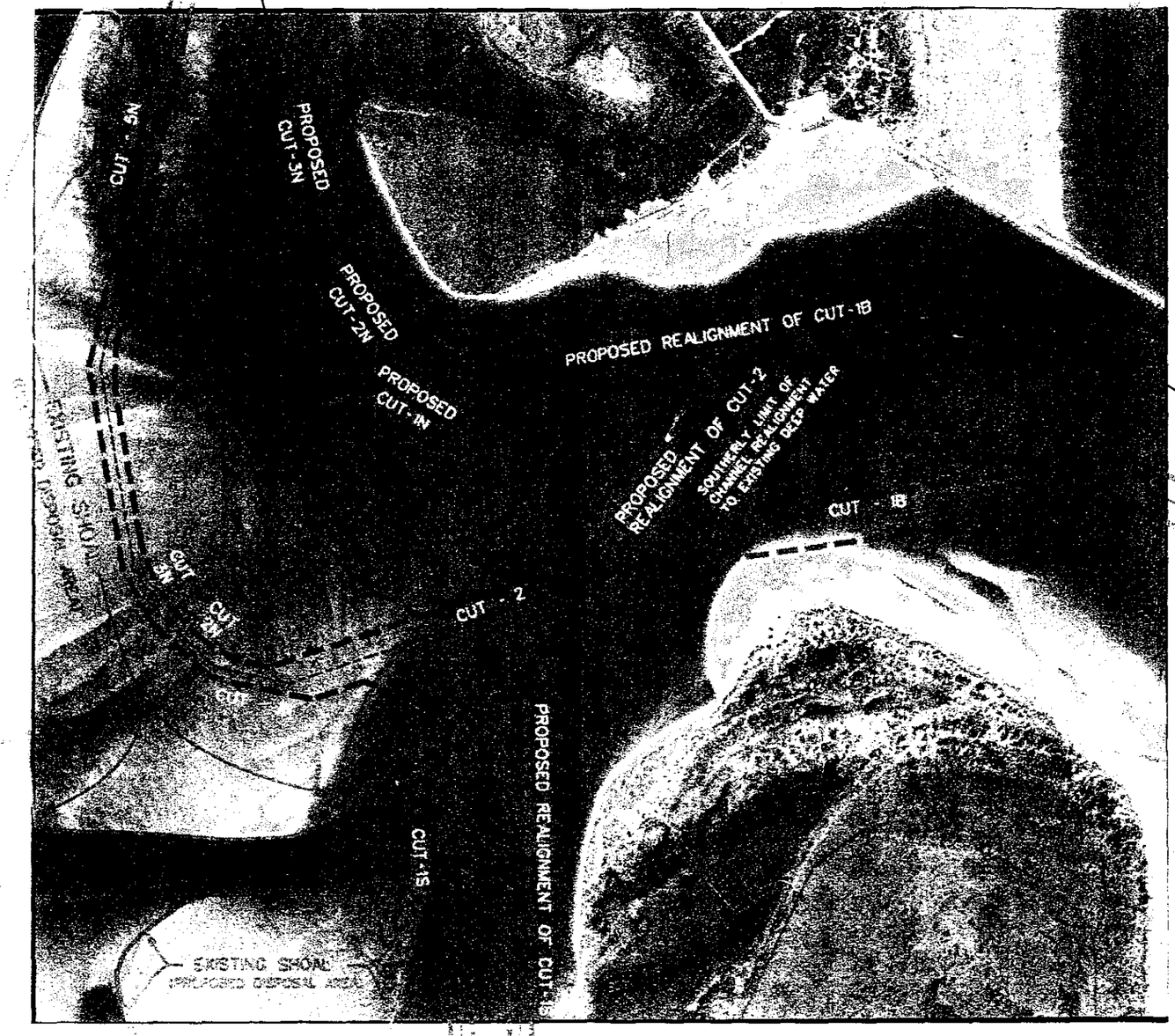
FIGURE 17

DESIGNED BY: DRAWN BY: CHECKED BY: SPC

SCALE: AS SHOWN DATED:

SHEET NO. 1 OF 1

D.O. FILE NO: ___ ___ ___



REVISIONS

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15 18 16 17

SHEET INDEX

GRAPHIC SCALE

200' 0 200' 400'

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

PONCE DE LEON INLET

CHANNEL DEEPENING TO 13W

PLAN 6

FIGURE 18

SIZE F

DRG

D.O. FILE NO:

SAFETY ON THIS JOB DEPENDS ON YOU

REVISIONS

NO.	DESCRIPTION	DATE	APP'D

PROPOSED SITE OF FISH PROCESSING PLANT AND VESSEL MOORING FACILITIES

CUT-V24 I.W.W.

CUT-V25

CUT-V26

LIMIT OF PROPOSED DEEPENING

MATCH LINE FIGURE 22

STA. 70+00 CUT V-24

STA. 80+00

STA. 84+00

STA. 90+00

STA. 820+00

STA. 0+00 CUT-V25

STA. 4+00 CUT-V25

STA. 4+34 CUT-V25

STA. 5+45 CUT-V25

STA. 6+45 CUT-V25

STA. 7+00 CUT V-26

SHEET INDEX

GRAPHIC SCALE

200' 0 200' 400'

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

PONCE DE LEON INLET
FEASIBILITY STUDY
7-, 12-, 15-FOOT PROJECT
IWW EXTENSION
FIGURE 19

DRN BY: SRC | CHK BY: | DATED: | SCALE: | DATED: | SHEET 1 OF 4

SAFETY ON THIS JOB DEPENDS ON YOU

REVISIONS				
NO.	SYMBOL	DESCRIPTION	DATE	APPR.

5 4 3 2 1

E D C B A

Yr. 1,716,000 Yr. 519,000 Yr. 1,715,000 Yr. 1,714,000 Yr. 520,000 Yr. 1,713,000 Yr. 521,000 Yr. 1,712,000

Xr. 485,000 Xr. 519,000 Xr. 520,000 Xr. 521,000 Xr. 522,000 Xr. 523,000 Xr. 524,000

MATCH LINE FIGURE 19 STA. 7+00 CUT V-26

STA. 0+00 CUT V-26

CUT - V 26 L.W.W.

STA. 3+00

STA. 5+00 CUT V-27

STA. 5+00 CUT V-27

CUT - V 27 L.W.W.

MATCH LINE FIGURE 21 STA. 8+00 CUT V-27

SHEET INDEX

GRAPHIC SCALE

200' 0 200' 400'

71

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

PONCE DE LEON INLET
FEASIBILITY STUDY
7-, 12-, 15-FOOT PROJECT
NW EXTENSION

FIGURE 20

SECTION CHIEF:			
DRAWN BY: SRC	CHK BY:	TYPE NO.	DRAWING NO. F
		DATED:	
		SCALE: AS SHOWN	DATED: SHEET 2 OF 4

F.P. FILE NO.

SAFETY ON THIS JOB DEPENDS ON YOU

REVISIONS

NO.	DESCRIPTION	DATE	APP'D

MATCH LINE FIGURE 22

MATCH LINE FIGURE 23

CUT-V27 I.W.W.

CUT-V28 I.W.W.

SHEET INDEX

GRAPHIC SCALE

200' 0 200' 400'

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

PONCE DE LEON INLET
FEASIBILITY STUDY
7-, 12-, 15-FOOT PROJECT
IWW EXTENSION

FIGURE 21

DESIGN BY:	DRAWN BY:	CHKD BY:
SRG		

DATED:

SCALE: AS SHOWN

PLOTTED:

SHEET 3 OF 4

SAFETY ON THE JOB DEPENDS ON YOU

REVISIONS

NO.	SYM.	ZONE	DESCRIPTION	DATE	APPD.

SHEET INDEX

GRAPHIC SCALE

200' 0 200' 400'

MATCH LINE FIGURE 19

MATCH LINE FIGURE 21

PROPOSED REALIGNMENT OF CUT-N

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

PONCE DE LEON INLET
FEASIBILITY STUDY
7-, 12-, 15-FOOT PROJECT
IWW EXTENSION

FIGURE 22

DRN. BY: SRC | CHK. BY:

DWG. NO. | SHT. NO.: F

DATED:

SCALE: AS SHOWN | DATED: | SHEET 4 OF 4

110. Plan G in combination with plans A and F provides additional project features that allow an increase in commercial benefits for project consideration. The increased commercial benefits result from the sponsor providing public dockage for commercial fishing vessels along with private development of a commercial marina and seafood processing facilities at the site of the former Swoope Power Plant as shown in figure 15.

111. An estimate of costs for a potential commercial marina and seafood processing facilities is included in the following Table 6. Of the total costs shown ($8,689,000) approximately $7,139,000 can be considered a without-project or sunk cost resulting in a total of $1,550,000 in associated costs to be included in the total project first costs.

ENVIRONMENTAL CONSIDERATIONS

112. Initial environmental coordination with appropriate Federal, State, and local organizations during the Reconnaissance Study began with a September 29, 1992, letter describing alternatives under consideration. That letter was followed by a February 7, 1995, letter during the Feasibility Study adding two additional alternatives not previously considered. With the addition of a deepening alternative involving the extension of the south channel along the IWW, a coordination letter dated March 18, 1997 was provided. All environmental and other coordination correspondence is included in appendix C and/or referenced in the Environmental Assessment (EA).

113. Implementation of the proposed alternatives will help stabilize the inlet and associated environments. Placement of armor stone for the south jetty extension will provide additional hardground in the area for colonization by organisms similar to those now inhabiting the area. Hardening and protection of the shoreline along the sand spit on the west end of the north jetty will cover approximately 2.1 acres of wetlands but at the same time protect nine acres of existing wetlands/uplands habitat. Approximately 6.6 acres of that nine acre protected area are wetlands. Placement of stone or other shoreline hardening material is expected to provide a net 4.5 acre (6.6-2.1) savings of wetlands when compared to the without project condition which results in a loss of all the existing wetlands/uplands located west of the north jetty.

114. No Action Plan. If nothing is done to stabilize the inlet, wetland areas within the immediate vicinity of the inlet will continue to have impacts. The sand spit with adjacent wetlands will continue to be impacted by erosion and filling to correct for erosion. While that area is impacted through changing conditions, other areas nearby are accreting with the overall impact to wetlands being somewhat minimal. Shoaling north of the south jetty is covering the rock jetty in that area which is a loss of hard ground. The north jetty instability and shifting of the rocks impacts the attached marine life. Boating accidents in the inlet may result in minor spills of oil and fuels as well as other chemicals.

Table 6

Commercial Fishing Facility Estimated Total First Costs

ITEM	COST
Stormwater Retention	$28,000
RE- Land	$1,125,000
RE- Site Preparation/Remediation/Permits	$212,500
Seafood Processing Fit-Out	$1,550,000
Marine Ramp Railway Fit-Out	$43,000
Commercial Facility	
Docking Facility	$236,947
Fish Processing Facility	$3,231,134
Ice Plant Facility	$198,463
Fuel Storage Facility	$28,590
Bulkhead	$485,778
Roadway Improvement	$131,511
Outdoor Lighting	$10,292
Tie in to local utilities/sewage	$55,721
Pavement for parking area	$522,359
35X70 Warehouse for Storage	$180,000
Boat Ramp / Railway	$10,423
Total Associated General Items	$8,049,718
Contingencies	$639,512
Total First Costs	$8,689,230

115. As stated in the U.S. Fish and Wildlife Service (USFWS) Coordination Act Report:

> The most significant impact to natural resources for the no action alternative would be the projected loss of the remaining salt marsh and mangrove swamp habitat, and all the associated biomass, from continued advanced erosion of the north spit of the old riverbed. The accompanying movement of sediment and nutrients into the water column is also likely to affect organisms within the benthic and sub-littoral zones. These effects, especially for the open water fauna and flora, likely will be transitory due to the speed and range of shifting physical conditions typical of most inlets. The presence of an extensive marsh and mangrove system both north and south of the inlet would also tend to lessen the overall impacts

of wetland loss. Additional shoaling in the Halifax River resulting from a break-through would impact the local benthos at that site. Shoaling may also reduce exchange of water and sediment from the boat basin cove, creating conditions favorable for expansion of the adjacent salt marsh and mangrove swamp. Degradation of the north jetty would expose more rock to the littoral and sub-littoral zone and provide additional shelter for fish and some crustacea as well as living surface for various algae and molluscs. Further expansion of the littoral zone adjacent to the inlet side of the south spit would likely benefit some benthic organisms, shorebirds, and nesting turtles. A breach behind the north jetty would remove some beach and foredune habitat and encroach on the transitional dune area. Fish, sub-littoral benthic organisms, and other tidal rock inhabitants would, on the other hand, have new habitats to exploit.

116. Plan A - South Jetty Extension. Construction and post-construction impacts from extending the south jetty 1,000 feet include the following as stated in the USFWS Coordination Act Report, found in the Environment Assessment section of this report:

> Impacts from increased boat and barge traffic expected during construction of the jetty extension include temporary displacement of fish, plankton, and some loafing and feeding shorebirds, permanent loss of some sand-bottomed, benthic habitat within the jetty footprint, and possible impacts to manatees and sea turtles, which will be covered in the section on threatened and endangered species. Direct habitat impacts expected or predicted during the post-construction period include the addition of more dry and tidally-influenced, hard rock substrate; sand accretion to varying degrees along the beach upwards of a mile south of the new jetty; and loss of some shoals and extended beach along the north side of the south spit. The sand accretion predicted for the south beach will directly benefit shorebirds, benthic species found within the littoral and sub-littoral zones, nesting sea turtles, and other upper beach fauna and flora. The dune habitat in this area and its associated biotic community will also benefit from the increased availability of sand necessary for the maintenance and growth of this habitat type. These benefits will more than offset the predicted loss of some littoral and sublittoral habitat adjacent to the south side of the inlet throat.

117. Plan B - North Jetty Weir Opening. USFWS has the following comments on reopening the weir in the north jetty:

> Reopening of 1,000 feet of weir would require removal of 255 feet of concrete walkway atop the jetty and approximately 17,000 tons of armor stone. If walkway demolition and rock removal is a land-based operation, the work would involve transporting equipment over the beach, then filling in jetty voids with stone to create a smooth, driveable surface for the heavy equipment. Part of the beach may be used as a staging

area for materials. Some transient impacts to upper beach fauna and flora may occur, as well as temporary displacement of feeding and loafing shorebirds. A water-based operation may temporarily effect shorebirds, fish, plankton, and the sub-littoral benthos. Removal of the submerged rock would reduce the total amount of hard substrate available to algae and aquatic and semi-aquatic marine invertebrates. Dredging of the impoundment basin would have short-term, open water and benthic impacts. Dredged spoil used for beach renourishment may impact nesting sea turtles, crustacea and other littoral benthos, while careful deposition in already existing and permitted spoil disposal sites is likely to have only minor impacts on an already disturbed plant and animal community.

The major change expected from the weir reopening is movement of additional sediment into the inlet from renewed littoral drift across the north jetty. Some of this sediment is expected to be deposited in the adjacent impoundment, where it may be piped or dredged to renourish south jetty beaches. Other sediment may be carried further into the inlet, where it will likely be involved in formation and maintenance of shoals, sandflats, and possibly accretion of remaining interior sand beaches bordering the north and south spits. The beach and dunes adjacent to the north jetty may become narrower due to transport of sediment formerly available to renourish these habitats. With the exception of dredging and artificial beach renourishment, the major expected change would potentially add new plant and animal habitat to the inlet. Since the greatest possible change to the north beach and dune system is likely to occur in the immediate vicinity of the north jetty, the overall impact to fauna and flora is not expected to be significant.

118. Plan C - Channel Realignment. According to USFWS:

The dredging in open water will remove the existing benthic community within the excavated area. Turbidity, especially within the old riverbed, will likely have a temporary, though possibly significant impact, on plankton and fish. Water-based operations may temporarily increase the risk of impacts to manatees and sea turtles. Land-based operations will remove some terrestrial plants and temporarily displace some animals, possibly including the Atlantic salt marsh snake. Up to three acres of mixed salt marsh, mangrove swamp, and sand beach will be lost due to their location within the footprint of the channel. In-kind mitigation would be required for the loss of the vegetated wetlands. Dredging would generate approximately 193,000 cubic yards of spoil. Beach-quality material may be used in renourishment projects, subject to further review for potential impacts to nesting sea turtles. Other spoil should be deposited within permitted and active disposal sites to minimize potential impacts to fish and wildlife resources. Permitted but inactive sites and

new sites without wetlands under consideration for disposal should first be assessed for occurrence of and potential impacts to federally-listed species. New potential sites with possible wetland impacts would first require a review of all fish and wildlife resources for possible impacts.

Some recolonization of dredged areas within the vicinity of the inlet and Halifax River should occur, and produce a benthic structure similar to the existing community. Significant changes in depth, current, salinity, and bottom sediments are expected within the old riverbed following dredging. This new habitat and the organisms which will colonize and otherwise use it should more closely resemble that occurring within the inlet and Halifax River. If this alternative produces greatly reduced water velocities on the flood tide in the vicinity of the spoil disposal peninsula, some accretion and low and high marsh formation may occur on the peninsula's southwest shore. If landward water velocities are not significantly diminished over current conditions, some erosion, possibly significant, may occur along the same shoreline. This in turn would likely have short-term impacts on the open water and benthic communities.

119. Plan D - Groin Field. USFWS acknowledges that:

The construction of a set of three groins along the sand spit inside the inlet adjacent to the north jetty was originally considered to preserve the remaining shoreline and prevent breaching of the spit by deflecting flood tide currents away from the spit. Since this alternative was considered in the Reconnaissance Report, more than 60 acres of remaining sand spit and marsh have been lost to erosion. As a result these physical changes to the north spit since publication of the Reconnaissance Report, the Corps has reviewed this alternative and determined that the current conditions no longer matched the parameters under which the groin field was to operate. The Corps therefore decided to drop this alternative from the project consideration and the biological assessment of its impacts to natural resources became unnecessary.

120. Plan E - Landward North Jetty Extension (Maintenance).
USFWS says the 800-foot long landward extension of the north jetty:

would impact approximately 2.85 acres and transverse a portion of the existing sand barrier as well as some backdune habitat. The few plants which colonized the sand barrier were found adjacent to the backdunes and marsh. Animal use of this sand deposit is likely to be transitory rather than permanent. The permanent loss of the backdune habitat within this section will not be significant since the adjacent Lighthouse Point Park consists primarily of this type of habitat.

121. Plan F - Revetment. According to USFWS the 1,540-foot revetment:

would impact a total of approximately 4.27 acres including between two and three acres (2.1 according to Corps calculations) of tidal mud flat, low and high salt marsh, and mangrove swamp. Impacts to tidal mud flats would be temporary, since sedimentation and backfill would be expected to cover at least that portion of the revetment where the impacts occur below mean low water. In-kind mitigation would be required for the loss of the vegetated wetlands. This habitat is also within the range of the federally endangered, Atlantic salt marsh snake. The discussion of possible impacts to this species may be found in the section on threatened and endangered species. Impacts to the additional 1.72 acres of open spoil field is not likely to be significant since this sparsely vegetated habitat appears to offer minimum wildlife function and value. The loss of the mixed herbaceous and woody transitional area also will not be significant because similar habitat on the peninsula still exists as well as more extensive habitat on the north side of the marina cove.

An indirect impact of the revetment is the possible mortality of some sections of mangroves adjacent to the revetment due to the blocking of tidal flow between the old riverbed and the peninsula's wetlands. Depending upon rainfall and tidal influence, these areas may convert into a more herbaceous, high marsh, or become a salt barren. Both of these habitats have unique functions and values which can be of special benefit to both resident and transient wildlife. Any indirect loss of mangrove swamp must be added to the mitigation required for the direct impacts.

Few upland or transitional plants, and terrestrial animals are likely to utilize the dry portions of the revetment. Estuarine organisms may utilize that portion of the revetment on both sides that are under regular and irregular tidal influence. Should the remaining north spit marsh erode and inlet breakthrough occur, some portion of the entire southwest side of the revetment is predicted to be under littoral and sublittoral influence. The pattern of floral and faunal use of this area is then expected to be more like that of the north and south jetties.

122. Plan G - South Channel Extension. The July 23, 1997, U.S. Fish and Wildlife Coordination Act Addendum for the Ponce DeLeon Inlet states:

Upland Disposal Sites Concerning the upland disposal sites MSA 434/434C North and South, Both sites historically were used as disposal sites for the IWW.

The north site (MSA 434) is approximately 378 acres, and appears not to have been used as a disposal site for many years based on the growth of the vegetation throughout the area (figures 8-10). The

predominant vegetation is wax mytrle, cabbage palm, red cedar, lantana (Lantana spp.), smilax (Smilax spp.), and sea oats (Uniola paniculata). During a cursory survey, four active gohper tortoise (Gopherus polyphemus) burrows were found, and one gopher tortoise was observed in a burrow (figure 11).

The south site (MSA 434C) is approximately 47 acres, and appears to have been used more recently than the north site (figures 12-14). There has been little recruitment of vegetation on the disposal site. The predominant vegetation is sea oats.

The Service believes the use of the south site would have less environmental impact than the north site because it lacks the plant or animal diversity observed on the north site.

Shoal Sites The shoaled areas are located between the inlet and the mouth of Rockhouse Creek. As shown in figures 15-19, the shoals are unvegetated, except one small patch of smooth cordgrass found on the extreme south end of the south shoal. Between the shoals and the islands, there were exposed tidal flats. Several unidentified shore birds were feeding on invertebrates found on these flats.

Of the three proposed methods of disposal available to the Corps for this project, the Service ranks the shoaled sites as the least favorable. The shoaled areas do provide feeding sites for shore and wading birds.

Beach Disposal Site The proposed beach disposal site begins south of the south jetty and will continue south along the beach until 360,000 cubic yards of sand is disposed of. The Corps did not identify a termination point.

Sandy beaches are populated by small, short-lived infauna with high species density and substantial reproductive potential and recruitment, for example decapods crustaceans, bivalves, spionid worms, and burrowing haustoriid amphiopods. These communities occur in relatively well-defined zones and depend to some extent on the nature of substrate.

The southeastern beach mouse (Peromyscus polionotus niveiventris), a Federally listed threatened species, may be found in the dune system. The marine turtles identified above may nest on the intertidal beach and supralittoral zones.

The dredged material will be piped from the project site to the beach to be dispersed. Work will be confined to the intertidal beach and supralittoral beach zones; no work will be conducted in the dunes.

Other than the impacts and conditions discussed in the enclosed biological opinion, the Service believes the impacts of beach disposal will be temporary. The invertebrates will recolonize the intertidal and supralittoral beach zones shortly after disposal.

123. Historic Properties. The area of impact for the proposed project includes both uplands and submerged lands. Therefore, historic property analysis for the Feasibility Study included consideration of both terrestrial and submerged cultural resources. Significant historic properties have been identified in the inlet vicinity. Unidentified historic properties may also be located in the area.

124. Based on archival research and consultation with the Florida State Historic Preservation Officer (SHPO), it was decided that a magnetometer survey should be conducted for the proposed jetty extension. During diver investigation of seven potentially significant targets, no historic materials were identified in the study area.

125. Terrestrial archaeological surveys were conducted for Lighthouse Point Park, north of Ponce DeLeon Inlet. The landward extension of the north jetty may affect the foundation remains of the Hotel Inlet Terrace. The survey archaeologist and the SHPO agreed that this site is not eligible for listing in the National Historic Register of Historic Places. Although the Corps of Engineers does not have any responsibility for this site for compliance with Section 106 of the National Historic Preservation Act, the non-Federal sponsor may want to relocate an interpretive sign and part of the foundation.

126. Correspondence appendix C contains two letters, dated June 30, 1997, and August 27, 1997, from the SHPO. The first indicates that realignment and extension of the south channel of the Ponce DeLeon Inlet project to about Cut-24 of the IWW will have no effect on historic properties listed or eligible for listing in the National Register of Historic Places. The second letter confirms the same no effect determination for the two proposed Dredged Material Management Areas (DMMA) MSA 434/434C North and South.

127. Aesthetics. An evaluation of the aesthetics of the alternative plans reveals the following considerations:

- Quarry and use native stone for the jetty extension and revetment which would blend with the surrounding environment and fit in its unnatural landform (if engineering design and costs considerations allow);

- Cover the jetty extension and revetment with local sand to conceal the rock and plant with native vines (backfill will be used along revetment to restore existing grades and allow natural re-establishment of flora); and

- Cover the rubble jetty with a capped concrete walkway accessible for recreational purposes (not a Corps option due to budget priorities).

128. Recreation. The impacts to existing and future recreational facilities from consideration of the alternative plans involves the following. Loss of access to the fishing pier located on the north jetty results if the No Action Plan occurs. With the 1,000-foot extension of the south jetty , Plan A, accretion of the beach south of the south jetty will occur for about one mile according to the Genesis Model work discussed in appendix A. That improvement should enhance recreational opportunities for the Smyrna Dunes Park. Future recreational opportunities under investigation by the Ponce DeLeon Inlet Port Authority include possible development of two existing dredged material disposal islands located north and south of Rockhouse Creek. In a report titled *Increasing Recreational Use and Profitability of Parks and Lands in the Ponce Inlet Area: A Conceptual Articulation* (Michael L. Avery and Dr. Daniel K. Rosetti) dated May 21, 1996, the authors recommend developing a water taxi service between the north and south parks and an accessible Mainland site. They suggest development of a Comprehensive Use Plan for the disposal islands and development of a recreational complex on the islands.

MITIGATION RECOMMENDATIONS

129. In a letter dated 10 July 1996 the Environmental Branch of the Jacksonville District explained that a comparison of the without project condition to Plan F resulted in a net gain of approximately 4.5 acres of wetlands. As a result Plan F should not require mitigation (U.S. Fish and Wildlife Service). The footprint and side slope area of the revetment of Plan F covers 2.1 acres of wetlands. The revetment of that plan protects approximately 6.6 acres of wetlands. The area saved or net gain as result of Plan F is 4.5 acres (6.6-2.1). If Plan F is not built, that area will erode and be totally lost by the year 2002 according to a shoaling analysis provided by Taylor Engineering (Taylor Engineering, 1996, Vol. 1, p. 3-7). While no mitigation is required, USFWS recommends as a minimum the Corps should make every effort to maintain the current tidal flat, fringing salt marsh, and mangrove swamp located between the old Halifax riverbed and the adjacent spoil upland.

130. Plan F - Revetment. According to USFWS the Corps should observe the following conditions to the maximum extent practicable:

- Align the channel and/or revetments to reduce their direct or indirect impacts on the preceding jurisdictional wetland.

- Where wetland impacts are unavoidable, dredge and fill operations should be conducted in a manner that restores the existing grade and dimensions of those wetlands prior to completion of the projects. This strategy will promote natural re-establishment of the biota associated with the tidal flat, salt marsh, and mangrove swamp.

- Artificially plant the dominant salt marsh and mangrove flora on the appropriate impacted areas at low densities to initially stabilize all areas and provide starter stock for those areas that are furthest from contiguous natural vegetation and less likely to be adequately vegetated through natural re-establishment.

ENDANGERED SPECIES

131. The proposed work for inlet stabilization is not expected to adversely affect any threatened or endangered species. The National Marine Fisheries Service (NMFS) in their September 10, 1996 letter in appendix C determined that endangered or threatened species under their purview would not be adversely affected by the proposed project.

132. In response to the District letter dated March 18, 1997, requesting comments on realignment of the south Ponce DeLeon Inlet channel and extension of it along the IWW north to the site of the former Swoope Power Plant, NMFS provided comments on the deepening and location of a commercial marina in their letter dated April 16, 1997, of appendix C. NMFS requested that the models (numerical and physical) used in testing of alternatives for the study be modified to assess the impacts of channel deepening on tidal flows, freshwater input flows, currents and salinity regimes.

133. The numerical model was modified to include testing of increasing the design depths of the affected channel reaches from 12 feet to 16 feet. While impacts on hydrodynamics and sediment transport were obtained, salinity changes were not part of the modeling process. The same numerical, two-dimensional hydrodynamic model and companion sediment transport methodology used earlier was modified to test channel deepening on three different inlet conditions. The conditions included existing 1994 inlet bathymetry, an expected future inlet bathymetry (channel through the inlet's north spit with a submerged shoal), and an alternative future inlet bathymetry (channel through the north spit with an emergent island). Each of the three conditions contained the proposed 1,000-foot south jetty extension.

134. The model testing revealed minimal hydrodynamic and sediment transport impacts for all three inlet conditions. Changes in velocities within the deepened IWW cuts ranged from 0.02-0.04 feet per second during both flood and ebb. According to Taylor Engineering, operating under the limitations of the present sediment transport methodology, existing sedimentation/erosion regimes are expected to be largely unaffected by the proposed deepening of the IWW (Taylor Engineering, 1997).

135. A review of bathymetric surveys of the Ponce DeLeon Inlet in appendix A indicates naturally occurring depths of 16-27 feet already exist in the entrance and south channel of the inlet over an area approximately three times the width of the existing south 100-foot wide channel. Some depths within 50-100 feet of the north jetty

range up to 40 feet. Due to the naturally occurring depths of 16-27, the south channel of the inlet requires only realignment with little or no dredging. Since the cross-sectional areas of the existing deep water are much greater than the dredging prism of 14-16 feet deep by 100 feet wide, no significant change in the salinity regime of the inlet is expected.

136. Based on model testing hydrodynamic results, velocity changes in the IWW indicate no to subtle variations. Therefore, salinity variations within the waterway are also considered to be non-detectable.

WATER QUALITY CERTIFICATION

137. The District prepared a document entitled *Draft Preliminary Environmental Assessment for Maintenance Dredging of Ponce DeLeon Inlet* (dated June 1996). A Florida Department of Environmental Protection (FDEP) request for additional information was responded to on January 4, 1999. The permit request for maintenance dredging of the study area involves removing an anticipated 500,000 cubic yards of material every four years. Placement alternatives for the dredged material include the north (secondary) and south (primary) beaches. FDEP notice of intent to issue a Water Quality Certificate is scheduled for February 1999. As of this writing no plans for maintenance dredging are funded or scheduled through FY-1999.

INITIAL ALTERNATIVE EVALUATION

138. The planning objectives, previously discussed, provided the basis for evaluating each of the alternatives. Plan consideration had to consider several problem areas at the inlet for stabilization. One was possible solutions to prevent the undermining and outflanking of the north jetty. Another was potential solutions to prevent a catastrophic or periodic breakthrough of the spit on the west end of the north jetty in the future. Cumulative problems from the breakthroughs have a negative economic impact on commercial fleet operations in the area. Yet another consideration was protective measures for public property in the way of a potential breakthrough. The fourth consideration involves solutions to minimize changing conditions in the navigation channels to improved navigation safety. A fifth concern involved providing adequate public docking facilities to attract sufficient commercial vessels to provide benefits for justification of the improvements. To address those problems, several improvement features were identified as alternative plans for consideration. An initial assessment of those plans in appendix A provides an engineering evaluation on each alternative. To achieve the planning objectives, a combination of plans would be necessary for an overall solution to problems.

139. Cost Estimates. A description of each alternative plan is discussed under the ALTERNATIVE PLANS section of this report. The engineering analysis and cost estimates provide information to make evaluations in preparing the design conditions for estimating costs. The estimates of total first cost for the following alternatives are in Table 7: Plan A/F, Plan A/F/G14, Plan A/F/G15, Plan A/F/G16, Plan A/F/G17, Plan A/F/G18, and Plan A/F/G19. The costs for Plans A/F and G are estimates just for those plan features. The combination of plans A/F or Plans A, F, and G are required to meet planning objectives. Plans A and F represent non-separable elements. Plan A, the 1,000-foot extension of the south jetty, causes the entrance channel to relocate toward the center of the inlet away from the north jetty. Plan F, the 1,540-foot revetment, protects commercial vessel marinas in addition to remaining wetland/upland areas and prevents the north jetty from being outflanked. Plans B, C, and D did not satisfy planning objectives and were removed from consideration. Plan E, the 800-foot landward extension of the north jetty, involves future maintenance work and requires implementation by the year 2002 either with or without a project to prevent outflanking of the north jetty.

140. The average annual equivalent costs for each of the alternatives are shown in Table 7. The combination of various alternative plans is required to accomplish stabilized conditions in the inlet and an overall reduction in maintenance cost. Currently a natural process of relocation of the existing deepwater channel toward the north jetty is occurring which results in greater than required depths for navigation. With the 1,000-foot south jetty extension improvement a shifting of the entrance channel away from the north jetty and more toward the center of the inlet is expected. Allowing the channel to shift northward naturally will gradually shift the channel with little or no maintenance. Future maintenance costs are discussed in the SELECTED PLAN section. Savings in prospective future maintenance are provided in that discussion. Interest and amortization of first costs plus interest during construction is at an interest rate of 7 1/8 percent over an economic analysis period of 50 years.

141. Assessment. The various alternative plans offer the potential for a number of combinations. However, cost was a major consideration since testing of plans with a combined numerical and physical model reduced the evaluations to just Plans A, F, and G which met planning objectives. Model tests indicate that the south jetty extension (Plan A) is a necessary component of all plans. A combination of Plans A, F, and G seems to best meet the planning objectives. Model tests indicate that Plans A and F should help shift the entrance channel away from the north jetty reducing impacts on that structure and possible loss of public property, wetlands, and structures. With a more stable system of channels boater safety should improve to help reduce damages and loss of life in the area. Plan G provides access to public docking facilities for commercial fishing vessels requiring a 14-foot or greater project depth. The additional features of plan G allow an increase in commercial benefits.

INITIAL BENEFIT ANALYSIS

142. The proposed improvements are to provide more stability for the navigation project at Ponce DeLeon Inlet. With a more stable inlet the navigation problems associated with the shifting channels and shoaling will be reduced significantly. Maintenance will also be less of a problem and the USCG will be able to mark the north channel for the project. The benefit analysis provides the economic impact of existing and prospective future conditions on boaters using the inlet with and without improvements. The analysis also evaluates past maintenance problems and possible future conditions with and without project improvement. Appendix D provides a description of the benefit analysis categories. The two main groups of benefit categories described in appendix D include transportation savings for both commercial and recreational vessels. The discussion on transportation savings that follows presents savings for alternatives considered with the fishing park and without the fishing park.

143. Commercial Small Boat Traffic. The benefit analysis evaluated the impact of the with and without project improvement conditions on existing and prospective commercial small boat usage in the inlet. Those boats included charter boats, head boats, and commercial fishing and shrimp boats. During the reconnaissance and feasibility studies, interviews with commercial fishermen, charter and head boat operators, and boatyard operators indicated that the commercial fleet for Ponce DeLeon Inlet consists of 80-85 vessels. Of that 58 boats were home port vessels and 26 were transient commercial fishing boats.

144. The 58 home port vessels were at marina, commercial fish houses, and boatyard locations within a 15-mile radius north and south of the Inlet. The identified fleet north and south of the inlet consists of 38 percent commercial fishing boats, 59 percent charter fishing boats, and 15 percent commercial passenger vessels or "head boats". The commercial fleet, identified south of the inlet, consisted of one head boat, eight commercial fishing boats, and six charter boats. About 26 transient commercial fishing boats visit a commercial fish house to the south on a regular basis.

145. Reductions in Damages to Commercial Boats. The USCG letter in appendix D provides a record of actual incidents in the inlet from search and rescue data on file. That information indicates a total of 347 vessel groundings from 1981 to 1991. Almost all of those groundings resulted from shoaling conditions on the Federal project. Those conditions occurred between the north and south jetties of the inlet, in the Halifax River channel to the north, in the Indian River channel to the south, and in the throat of the inlet at the junction of those two channels near Rock House Creek as shown on plate 1 of appendix D. Discussions with USCG personnel at their Ponce DeLeon Inlet Station indicate that those records do not reflect all the incidents. If a vessel runs aground and is not in immediate danger, the USCG does not respond nor record the incident. Operators of grounded vessels not in immediate danger must rely on others such as

146. Interviews with personnel at four marinas with boatyards as well as one propeller and shaft repair facility on the north side of the inlet provided information for estimating damages. Those facilities apparently experience the major portion of repairs associated with damage in the inlet. From their information the estimated boat damage on the Federal project at the inlet averages about 12 propeller and shaft jobs per week during the course of a year. Those boatyards have the capability to haul the boats for removal of propellers and shafts. Once off the boat, the propellers and shafts go to a separate facility that actually does the repair work then returns the repaired parts to the boatyard. The boatyard then puts the parts back on the boat. Estimated costs for such repairs for commercial vessels range from a low of about $220 to a high of over $2,300. The average cost estimate for that repair work is about $860 per boat.

147. With improvements to the inlet and more stable inlet channels, the USCG would be more agreeable to reestablishing the navigation markers in the north channel. With the channel markers and more stable inlet conditions, the propeller and shaft repairs could be reduced.

148. Existing Commercial Boat Benefits Summary (with inlet stabilization measures only - plans A&F). Categories of average annual benefits for existing commercial vessels include the following:

- Reductions in general vessel damages/maintenance avoided for commercial vessels, $200,710;
- Avoidance of charters lost or forgone, $47,520;
- Avoidance of severe damages/catastrophic losses, $10,750;
- Reduction in labor and damage costs for sea trials, $32,000.

149. Those average annual equivalent (AAEQ) benefits total $290,980 for the existing vessel fleet using the inlet.

150. New Commercial Fishing Vessel Benefits (with public docking facilities and commercial marina - plans A,F, & G). Recent information indicates that a new fishery will soon be open for the harvest of golden and red crab. Projections reveal this new fishery will bring approximately 11 vessels to the inlet area for operations. With commercial fish processing facilities and dockage, fishing vessels with drafts requiring a 14-foot project depth will be able to visit Ponce DeLeon Inlet. Average annual equivalent benefits of approximately $321,950 per year are expected. Appendix D contains a description of the benefit analysis.

Table 7

Estimate of Initial[1] Alternative First Costs, Interest During Construction, Economic Investment, & Annualized Costs
Plans B, C, D, & E Not Shown

ITEM	PLAN A/F	PLAN A/F/G14	PLAN A/F/G15	PLAN A/F/G16	PLAN A/F/G17	PLAN A/F/G18	PLAN A/F/G19
Construction Costs	$6,987,000	$9,741,000	$9,914,000	$10,064,000	$10,258,000	$10,509,000	$10,773,000
Non-Construction Costs							
Real Estate	$20,000	$20,000	$20,000	$20,000	$20,000	$20,000	$20,000
Navigation Aids	$12,000	$12,000	$12,000	$12,000	$12,000	$12,000	$12,000
Planning, Engineering, Design	$209,000	$314,000	$314,000	$314,000	$314,000	$314,000	$314,000
Construction Management.	$256,000	$384,000	$384,000	$384,000	$384,000	$384,000	$384,000
Contingencies	$1,405,000	$1,585,000	$1,611,000	$1,634,000	$1,663,000	$1,701,000	$1,740,000
Total First Costs	$8,889,000	$12,055,000	$12,255,000	$12,427,000	$12,650,000	$12,939,000	$13,242,000
Interest During Construction	$605,000	$821,000	$834,000	$846,000	$862,000	$881,000	$902,000
Economic Investment	$9,494,000	$12,876,000	$13,089,000	$13,273,000	$13,512,000	$13,820,000	$14,144,000
Average Annual Equivalent (AAEQ) Costs							
Economic Investment	$699,000	$948,000	$963,000	$977,000	$995,000	$1,017,000	$1,041,000
Cost Savings With Project							
North Jetty Maint. Savings	($28,000)	($28,000)	($28,000)	($28,000)	($28,000)	($28,000)	($28,000)
Inlet Maintenance Savings	($72,000)	($72,000)	($72,000)	($72,000)	($72,000)	($72,000)	($72,000)
IWW Maintenance Savings	$0	$0	$0	$0	$0	$0	$0
Total AAEQ Costs	$599,000	$848,000	$863,000	$877,000	$895,000	$917,000	$941,000

[1]After the Feasibility Review Conference in March 1998 benefits and costs for the proposed fishing park could no longer be considered (see Refined Alternative Evaluation section) and these plans were no longer viable. They are included here to present a complete explanation of plan formulation.

Table 8
Initial[1] Benefit Summary

	With Fishing Park	Without Fishing Park
Benefit Category		
Commercial Vessel/Use	$612,900	$291,000
Recreational Vessel Use	$466,200	$466,200
Total Benefits	$1,079,100	$757,200

[1]After the Feasibility Review Conference in March 1998 benefits and costs for the proposed fishing park could no longer be considered (see Refined Alternative Evaluation section) and these plans were no longer viable. They are included here to present a complete explanation of plan formulation.

Table 9
Comparison of Initial[1] Plan Benefits/Costs

ITEM	PLAN A/F	PLAN A/F/G14	PLAN A/F/G15	PLAN A/F/G16	PLAN A/F/G17	PLAN A/F/G18	PLAN A/F/G19
Annual Benefits	$857,000	$1,079,000	$1,079,000	$1,079,000	$1,079,000	$1,079,000	$1,079,000
Annual Costs	$599,000	$848,000	$863,000	$877,000	$895,000	$917,000	$941,000
Net Benefits	$258,000	$231,000	$216,000	$202,000	$184,000	$162,000	$138,000
Benefit to Cost (B/C) Ratio	1.43[1]	1.27[1]	1.25[1]	1.23[1]	1.21[1]	1.18[1]	1.15[1]

[1]After the Feasibility Review Conference in March 1998 benefits and costs for the proposed fishing park could no longer be considered (see Refined Alternative Evaluation section) and these plans were no longer viable. They are included here to present a complete explanation of plan formulation.

151. Total Commercial Vessel Benefits. Commercial vessel benefits derived from the existing (without commercial fish processing facilities and dockage - plans A&F) and new fleets (with commercial fish processing facilities and dockage - plans A,F, & G) are the sum of $290,980 and $321,950. That value totals $612,930 in average annual equivalent benefits.

152. Total Recreational Vessel/Use Benefits (Plans A&F and plans A, F, & G). Benefits for reductions in damages to recreational craft and value of time saved for inlet users results in $307,840 and $158,330 respectively. Those values total $466,170 in average annual equivalent benefits. Those benefits are for recreational vessels and apply either with or without commercial fishing park facilities.

153. Maintenance. As a result of the continued migration of all the Federal navigation channels at Ponce DeLeon Inlet, operation and maintenance have been a continuous problem. A brief analysis of maintenance costs associated with historical repairs to the north jetty and past breakthrough indicate a significantly high maintenance record. Under current conditions plans for future maintenance work anticipate problems with the entrance channel up against the north jetty and spit. As a protective measure for the eroding eastern shoreline of the spit, maintenance work on the IWW was started in April 1994 and was completed in September 1994 with the placement of 215,000 cubic yards of material on that shoreline at an originally contracted cost of $1,000,000. Final settlement of that contract has not occurred as of this writing. That plan involved removing shoal material from the IWW near Rock House Creek and placing it on the east shoreline of the spit for protection against a breakthrough.

154. In early summer 1998 a scour apron was placed along the landward end of the north jetty and armor stone was placed to fill in slumped areas. Associated maintenance costs in 1995 and 1996 were incurred to determine the location for placement of the scour apron include $16,019 for a multi-beam sonar survey and $11,416 for a U.S. Army Diver's survey of the underwater portion of the north jetty. The contract award for the construction contract for the scour apron and additional armor stone to fill in slumped areas of the north jetty was $1,067,000 (Contract No. DACW17-97-B-0024).

155. Approximately 8-9 years from 1994, a recession rate analysis indicates that under current conditions, the north spit will erode to the area of the landward end of the north jetty (Taylor Engineering, 1996, Vol. 1, page 3-7). To protect the integrity of the north jetty Operation and Maintenance plans should include construction of an 800-foot landward extension of the north jetty prior to or not later than the year 2002.

156. North Jetty Repairs Savings. Stability of the north jetty is in question with the deep water very close to the structure. Jetty maintenance is expected to be a major expenditure in the future. A review of repairs to the north jetty in table 3 indicates the north jetty underwent both major and minor repairs over a period of time from FY-79

through FY-95. Major maintenance has just been completed on the north jetty to provide a scour apron and armor stone as previously described.

157. Without improvements to the inlet, three additions to the north jetty scour apron are anticipated once every 14 years from placement of the above mentioned scour apron in 1996. Using the cost of $1,350,000 for each of the three future scour aprons in the years 2010, 2024, and 2038 results in an Average Annual Equivalent (AAEQ) cost of $82,000. That figure is based on a 50-year economic project life starting in 2001 at a 7 1/8 percent interest rate. With improvements to the inlet the entrance channel is expected to shift away from the north jetty toward the center of the inlet. Under those conditions only one additional scour apron is anticipated in the year 2010. Using the $1,350,000 figure for its cost provides an AAEQ of $54,000. The difference in the without and with project conditions results in an AAEQ maintenance savings of $28,000.

158. Inlet Maintenance Dredging Savings. Since closure of the weir, past maintenance experience on the Federal channels of the inlet indicates removal of a total of 1,838,000 cubic yards of material from 1984-1997 (Table 10). Over that 13-year period the annual shoaling rate is 141,000 cubic yards.

159. Future maintenance dredging of the project with the 1,000-foot south jetty extension and the 1,540-foot revetment appendage to the landward extension of the north jetty is expected to be about 68,000 cubic yards per year. Dredging will probably occur at 5-year intervals when approximately 340,000 cubic yards of material has accumulated. As shown in table 10 no dredging of the Federal channels related to the inlet system has occurred since 1989. No dredging is planned for 1998 as of the date of this report.

160. While the Federal system of inlet channels has been unstable and required moving of the USCG navigation markers, adequate depths and widths have existed for navigation interests. Even though the USCG refuses to mark the north channel in the Halifax River due to its unstable condition, existing deep water for navigation has existed since 1989 in that and all Federal channels of the inlet system. As a result no dredging has been required. With a project in place adequate depths are expected to continue to exist while the inlet system of channels readjusts naturally to the project modifications. Without any navigation improvements the estimated average annual equivalent (AAEQ) maintenance dredging costs for a 50-year economic life of the project are $540,000. Starting with a 50-year economic life beginning in 2001 that figure assumes a $2,700,000 cost every five years to dredge 340,000 cubic yards plus a cost of $5,100,000 to dredge 887,000 cubic yards once in the year 2025. With navigation improvements the estimated AAEQ cost are $468,000. That figure assumes a $2,700,000 cost of dredging every five years. The addition of the 1,000-foot south jetty extension and the 1,540-foot revetment result in an AAEQ maintenance dredging savings of $72,000.

161. Other Considered Benefits. Other areas that would be affected include impacts associated with ongoing USCG maintenance. The owner of the boatyard on the north side of the inlet indicated that he is constantly on the radio to assist boaters passing along the Halifax River channel which has no navigation markers. The USCG removed the markers along the north Halifax River channel to discourage usage because of erratic channel conditions. Many vessels still run aground in the river trying to use the waterway for access. Those that do run aground often turn around and go back in fear of having further groundings.

162. As a result of the grounding problem, some boaters avoid the unmarked Halifax River channel and go around by way of the IWW to the south channel for inlet access. Those boaters to the north of the inlet must use more fuel to go around. The USCG also moves channel markers frequently along the south channel of the Indian River and in the entrance channel of the inlet. With a more stable inlet the monitoring and location of temporary channel markers until the regularly scheduled buoy tender arrives will result in a lower maintenance cost. Scallop boats also provide another source of benefits not currently claimed. A ship repair facility capable of handling larger fishing vessels will also provide additional benefits.

163. Summary of Benefits. Table 8 summarizes the initially estimated benefits from potential improvements to the Ponce DeLeon Inlet Federal navigation project. Average annual equivalent (AAEQ) benefits in that table are based on an economic period of analysis of 50 years for a project with a base year of 2001 and an interest rate of 7 1/8 percent. Benefits for the without fishing park Plan A/F and the with fishing park Plan A/F/G14 scenarios relate to commercial and recreational boating and to north jetty and inlet maintenance savings. Without a deeper channel to fish processing facilities and public docking the potential project consists of plans A and F (1,000-foot south jetty extension and a 1,540-foot revetment extending from the end of the 800-foot landward extension of the north jetty). AAEQ commercial and recreational boat benefits for plans A and F consist of $290,980 for commercial boats and $466,170 for recreational boats. Total benefits for plans A and F equal $757,150. AAEQ maintenance cost savings for plans A and F are $28,000 for the north jetty and $72,000 for the inlet. With a deeper channel (plan G) to commercial fish processing and public docking facilities combined with plans A and F, benefits increase to $612,930 for commercial boats and $466,200 for recreational boats. Total AAEQ benefits for plans A, F, and G are $1,079,100. The cost savings remain the same for maintenance of the north jetty and inlet.

INITIAL ECONOMIC SUMMARY

164. Table 9 is an initial comparison of plan benefits and costs. As indicated earlier, annual benefits are provided in AAEQ values and represent benefits from commercial and recreational vessel use. Annual costs are also provided in AAEQ values and represent economic investment, including construction costs, non-construction costs (real estate, navigation aids, planning, engineering and design, and construction

management), contingencies, interest during construction, and cost savings for maintenance of the north jetty and inlet dredging. Net benefits are calculated by subtracting annual costs from annual benefits. Benefit to cost ratios are calculated by dividing annual benefits by annual costs.

165. The analysis did not consider additional benefits in the areas of potential location of new boat construction/repair facilities nor scallop boats that might either off-load or provide scallops for processing at the new commercial marina facility. No savings claimed in USCG maintenance costs for monitoring and temporary marking of channels while waiting on buoy tender to make changes.

REFINED ALTERNATIVE EVALUATION

166. On July 24, 1997 a workshop/public meeting was held that discussed proposed plans to stabilize Ponce DeLeon Inlet. Included was a review of how Federal navigation projects are justified and the role of benefits in that justification. It was pointed out that Federal interest in stabilization measures for the inlet was highly unlikely due to a low proportion of commercial use benefits. It was suggested that with adequate commercial fishing facilities, if waterway usage occurred as a result of improvements and costs were reduced or revenues increased for commercial operations, benefits could be quantified to offset waterway improvement costs. These benefits could be used for project justification. A commercial fishing park was proposed at the site of the Swoope Generating Plant. Many of the alternatives evaluated during plan formulation included the commercial fishing park. After the proposal at the workshop there arose much public opposition to the commercial fishing park. As a result, the commercial fishing park will not be constructed.

167. In a letter dated March 2, 1998 (Appendix C) the County of Volusia presented a sponsor's preferred plan, which is Plan A, the 1,000-foot south jetty extension. This letter was presented by the County during the Feasibility Review Conference (FRC) on March 3, 1998. The letter requests removal from the project recommendations of the proposed commercial fishing park at the Swoope Power Plant location. The County investigated three other locations for a proposed facility, including the Feger's Seafood fish processing facility in the City of New Smyrna Beach, a marine industrial zoned site adjacent to the Boston Whaler boat plant south of New Smyrna Beach, and an existing location for commercial fishing charter vessels and repair facilities located on the north side of the inlet by the lighthouse. It was subsequently determined that the dredging costs associated with these alternatives were very costly which prevented further consideration. Also during the FRC it was discussed that plan F, the 1,540-foot revetment, could be constructed under the Corps' operations and maintenance program at a future date when necessary, after having been shown justified and approved as a warranted operations and maintenance expenditure. Therefore, the only viable plan is Plan A. The without project condition has been modified to include an assumption that

the Corps' would construct a 1,540-foot revetment under its operations and maintenance program.

REFINED COST ESTIMATE

168. The cost estimate prepared for the 1,000-foot south jetty extension is found in the Engineering Appendix, Appendix A. Table 12 presents the total cost for the 1,000-foot south jetty extension, interest during construction, and the average annual equivalent cost of the economic investment for the jetty extension.

REFINED BENEFIT ANALYSIS

169. Benefits associated with both commercial vessels and recreational vessels decreased since the proposed fishing park will not be constructed. The navigation benefits have been refined as presented in the following paragraphs. In addition, the benefits for maintenance savings have been refined. The additional numerical model analysis presented in Taylor Engineering's July 1998 report, "Engineering Benefits of the Proposed South Jetty Extension", serves as the basis for the refined maintenance savings benefits.

170. Commercial Vessel Benefits, Plan A (1,000-foot south jetty extension). Estimates for benefits to commercial vessels with just the 1,000-foot south jetty extension total an average annual equivalent value of $48,000.

171. Recreational Vessel Benefits, Plan A (1,000-foot south jetty extension). Estimates for benefits to recreational vessels with just the 1,000-foot south jetty extension total an average annual equivalent value of $262,600.

172. North Jetty Maintenance Cost Savings. Without improvements to the inlet, three additions to the north jetty scour apron, including crest restoration, are anticipated once every 14 years beginning in 2010. In addition, annual inspections are anticipated for the north jetty each year. Using the cost of $1,340,000 for each of the three future scour aprons in the years 2010, 2024, and 2038, and a cost of $7,500 for each inspection results in an Average Annual Equivalent (AAEQ) cost of $89,000. That figure is based on a 50-year economic analysis period starting in 2001 at a 7 1/8 percent interest rate. With improvements to the inlet the entrance channel is expected to shift away from the north jetty toward the center of the inlet. Under those conditions only one additional scour apron is anticipated in the year 2024, the midpoint of project period of analysis, and inspection is anticipated once every three years. Using the $1,340,000 figure for the scour apron repair and crest elevation cost and $7,500 for the inspection cost provides an AAEQ cost of $23,000. The difference in the without and with project conditions results in an AAEQ maintenance savings of $66,000.

Table 10

PONCE DELEON INLET MAINTENANCE DREDGING QUANTITIES FROM 1971

Reference: CO-ON O&M Dredging History Ponce DeLeon Inlet, FL - Final Contract Quantities (File MPONCD)

AREA BY REACH OR CUT	DATE	SITE	FINAL CONTRACT QUANTITY TOTAL (CY)[1]	DISPOSAL AREA	North Jetty Weir
Entrance Channel	7/71 - 2/72	Beach	178,000	South of South Jetty	Open
Impoundment Basin	8/71 - 8/72	Beach	400,000	South of South Jetty	Open
Entrance Channel	3/73	Ocean	25,000	Open Water	Open
Entrance Channel	3 - 4/73	Ocean	95,000	Open Water Offshore	Open
South Shoal/Entrance	4 - 8/74	Beach	89,000	North Beach	Open
South Shoal/Entrance	4 - 8/74	Beach	434,000	(Breach) Beach Closure	Open
Entrance Channel	5 - 6/75	N. Shore	138,000	Open Water N. Shore Beach	Open
Entrance Channel	3/76	N. Shore	13,000	Open Water N. Shore Beach	Open
Entrance Channel	8 - 9/76	Ocean	38,000	Open Water	Open
Not Listed	11/77 - 7/78	Beach	435,000	North Beach	Open
Entrance Channel	11/78 - 3/78	N. Shore	41,000	Near Shore at North Beach	Open
Entrance Channel	5 - 8/84	Beach	82,000	Not Listed	Closed (March 1984)
Entrance/Inner/S. Channels	4 - 5/85	Beach	887,000	Not Listed	Closed
Entrance Channel	89	Ocean	869,000	Not Listed	Closed
None	1990 - 1997	N/A	None	None	Closed
None Planned/Scheduled	1998	N/A	None	None	Closed
None Planned/Scheduled	1999	N/A	None	None	Closed

[1] Final Contract Quantity Rounded to Nearest 1,000 Cubic Yards

Table 11

INTRACOASTAL WATERWAY MAINTENANCE DREDGING QUANTITIES FROM 1952

Cuts V-22 to V-29

Reference: Taylor Engineering, Personal communication

CUT RANGE	DATE	QUANTITY (CY)[2]	DISPOSAL AREA	North Jetty Weir
V-22 to V-27	1958	149,000	Unknown	Open
V-22 to V-27	1960	120,000	Unknown	Open
V-22 to V-27	1962	88,000	MSA 434/434C	Open
V-22 to V-27	1963	38,000	MSA 434/434B	Open
V-24 to V-26	1964	81,000	MSA 434/434C	Open
V-24 to V-29	1966	66,000	MSA 434/434C	Open
V-22 to V-28	1967	110,000	MSA 434/434C	Open
V-22 to V-28	1968	225,000	MSA 434AR	Open
V-22 to V-28	1970	104,000	Unknown	Open
V-22 to V-28	1979	736,000	MSA 434/434C	Open
V-24 to V-26	1986	193,000	MSA 434/434C	Closed (March 1984)
V-23 to V-29	1994	215,000	South of North Jetty[3]	Closed
V-22 to V-29[1]	1996	193,000	Not applicable	Closed

[1]In 1996 the IWW was surveyed. The reported quantity represents the quantity of maintenance material in the channel at the time of the survey. There was no maintenance dredging event in 1996.

[2]Quantities rounded to the nearest thousand.

[3]Placement intended to slow erosion of spit south of North Jetty.

Table 12

Plan A 1000-Foot South Jetty Extension Project Sponsor's Preferred Plan - Interest During Construction (IDC)

Activity	Date	Month	Amount	FWF	FW	IDC			
Receive DE's Public Notice	Sep-98	0							
Start PED	Oct-98	1	$12,292	1.170846	$14,392	$2,100			
	Nov-98	2	$12,292	1.164150	$14,309	$2,018			
	Dec-98	3	$12,292	1.157492	$14,228	$1,936			
	Jan-99	4	$12,292	1.150872	$14,146	$1,854			
	Feb-99	5	$12,292	1.144290	$14,065	$1,774			
	Mar-99	6	$12,292	1.137746	$13,985	$1,693			
	Apr-99	7	$12,292	1.131239	$13,905	$1,613			
	May-99	8	$12,292	1.124769	$13,825	$1,534	Construction Cost	$5,225,833	
	Jun-99	9	$12,292	1.118337	$13,746	$1,455			
	Jul-99	10	$12,292	1.111941	$13,668	$1,376	PED Cost	$147,500	
	Aug-99	11	$12,292	1.105582	$13,589	$1,298			
Finish PED	Sep-99	12	$12,292	1.099259	$13,512	$1,220		$5,373,333	
Construction Funding Received	Oct-99	13	$0	1.092972	$0	$0			
PCA Development & Review Process	Nov-99	14	$0	1.086721	$0	$0	Total First Cost	$5,373,333	
	Dec-99	15	$0	1.080506	$0	$0	IDC	$281,553	
Construction Start	Jan-00	16	$580,648	1.074326	$623,806	$43,158	Economic Investment	$5,654,886	
	Feb-00	17	$580,648	1.068182	$620,238	$39,590	AAEQ's	$403,288	
	Mar-00	18	$580,648	1.062073	$616,691	$36,043			
	Apr-00	19	$580,648	1.055999	$613,164	$32,516			
	May-00	20	$580,648	1.049960	$609,657	$29,009	Project Economic Life:		50
	Jun-00	21	$580,648	1.043955	$606,170	$25,522			
	Jul-00	22	$580,648	1.037985	$602,704	$22,056	Current Rate:		6.875%
	Aug-00	23	$580,648	1.032048	$599,257	$18,609			
Construction Complete	Sep-00	24	$580,648	1.026146	$595,830	$15,181	Average Annual Equivalent		
Start Transfer and Acceptance	Oct-00	25		1.020277	$0	$0	(AAEQ) or Capital		
	Nov-00	26		1.014442	$0	$0	Recovery Factor(S):		0.071317
	Dec-00	27		1.008640	$0	$0			
Complete Transfer and Acceptance	Jan-01	28		1.002872	$0	$0			
					Total IDC	$281,553			
Notes:									

IDC based on PED taking place at uniform rate of expenditure at the middle of each month starting at 24 months prior to completion of construction for a period of 9 months

Also based on construction costs being incurred at a uniform rate at the middle of each month for the 9 months prior to completion of construction

173. Inlet and Intracoastal Waterway (IWW) Maintenance Dredging Cost Savings. Maintenance dredging savings are based on a reduction of sediment transported around the 1,000-foot south jetty extension into the inlet system. The inlet system consists of the Federal inlet project and the Federal Intracoastal Waterway (IWW) project, Cuts 22-29 (Taylor Engineering, July 1998, p.4). Taylor Engineering calculated an ongoing net shoaling rate within the immediate inlet interior (entrance channel, throat, middle section, north channel, and south channel) of 10,000-20,000 cubic yards per year (cy/yr) for the closed-weir phase (1984-present) (Taylor Engineering, July 1998, p.4). The average dredging volume for the IWW stretch influenced by the inlet, since weir closure is 46,000 cy/yr. Cumulative inlet shoaling for existing conditions is therefore between 56,000 and 66,000 cy/yr. This range is substantiated by the northerly transport rate of 55,000-60,000 cy/yr estimated using GENESIS modeling (Taylor Engineering, July 1998, p.5). With the south jetty extension, the backpassing sand volume into the inlet from the south should reduce markedly. About 20 percent of the current backpassing volume is assumed to persist given the unfilled length of the south jetty extension, the nature of the ambient wave climate, and the bathymetry in the vicinity of the south jetty (Taylor Engineering, July 1998, p.4). Taking 20 percent of the lower and upper bounds of the cumulative inlet system shoaling rates (55,000-66,000) yields a reduction in shoaling for the inlet system of 44,000-53,000 cy/yr.

174. For the closed-weir phase of Ponce DeLeon Inlet, ongoing net shoaling in the inlet is 10,000 to 20,000 cubic yards per year (Taylor Engineering, July 1998, p.4). While the Federal system of inlet channels has been unstable and required moving of the USCG navigation markers, adequate depths and widths have existed for navigation interests, although not always within the boundaries delineated on plans showing the authorized project. Even though the USCG refuses to mark the north channel in the Halifax River due to its unstable condition, existing deep water for navigation has existed since 1989 in that and other channels of the inlet system. To iterate, the existing deep water is not necessarily within the boundaries delineated on plans showing the authorized project. As a result no dredging has been required to achieve project depths, however, the areas with the deep water may not coincide with the locations described on plans of the authorized project. The last maintenance dredging for the inlet occurred in 1989 (Table 11); no maintenance is scheduled or anticipated for the future. Figure 23 shows the history of construction and maintenance dredging for the Federal inlet project and for the IWW, Cuts V-22 through V-29. It is assumed for the without project condition that there will be a maintenance event once every 10 years in the inlet. An assumed maintenance dredging interval beyond 10 years is unreasonable due to the high probability of a storm event causing shoaling in a given 10-year period. For example, using the formula

$$P = [1 - (1 - 1/T)^{L}] \times 100$$

where P = % chance encounter any given year in time interval

T = return period, years, and

L = maintenance dredging interval, years

the probability of a 10-year event occurring in a 10-year interval is 65.1%. The probability of a 20-year event occurring in a 10-year interval is 40.1%. The following statistics substantiate the choice of 10 years for the maintenance dredging interval: the greatest average number of years between events for the inlet system is 8 (for the IWW since the weir was closed), the maximum number of years between events is 9 (for the IWW since construction), and the minimum number of years between events is 1. These statistics are shown in a bar chart as Figure 24.

175. Using 20,000 cy/yr as the shoaling rate and a 10-year interval, each future maintenance dredging event would then consist of 200,000 cy of material. No advanced maintenance analysis was conducted for the inlet since such an analysis would lengthen the interval between events and doing so would be unreasonable. Material dredged from the inlet is expected to be beach quality and to be placed south of the south jetty. The average annual equivalent value for placing 200,000 cy of material on the beach every 10 years over the 50-year economic analysis period is $152,000.

176. The average shoaling rate for the IWW since the weir was closed is 46,000 cy/yr. The interval for maintenance dredging in the IWW is once every seven years. Both of these figures are calculated from the record of maintenance events in the IWW between Cuts V-22 and V-29, the area of influence of the inlet on the IWW. Using 46,000 cy/yr as the shoaling rate and a 7-year interval, each future maintenance dredging event would consist of 322,000 cy of material. An advanced maintenance analysis was conducted for the IWW in order to determine the most efficient maintenance dredging routine for this section of waterway. The analysis was conducted by considering dredging additional depth at each event and therefore lengthening the time between events. The analysis was completed for additional depths of one, two, three and four feet. The material dredged from the IWW is expected to be beach quality material. Both beach placement and placement in an upland disposal area with subsequent offloading of the disposal area when at capacity were considered. Using the same logic of a 10-year cap for the maintenance dredging interval, the advanced maintenance analysis resulted in a most efficient routine at an additional depth of two feet with an interval of once every 10 years, and placement directly on the beach. The average annual equivalent cost of maintenance dredging in the IWW, for the without project condition, is $226,000.

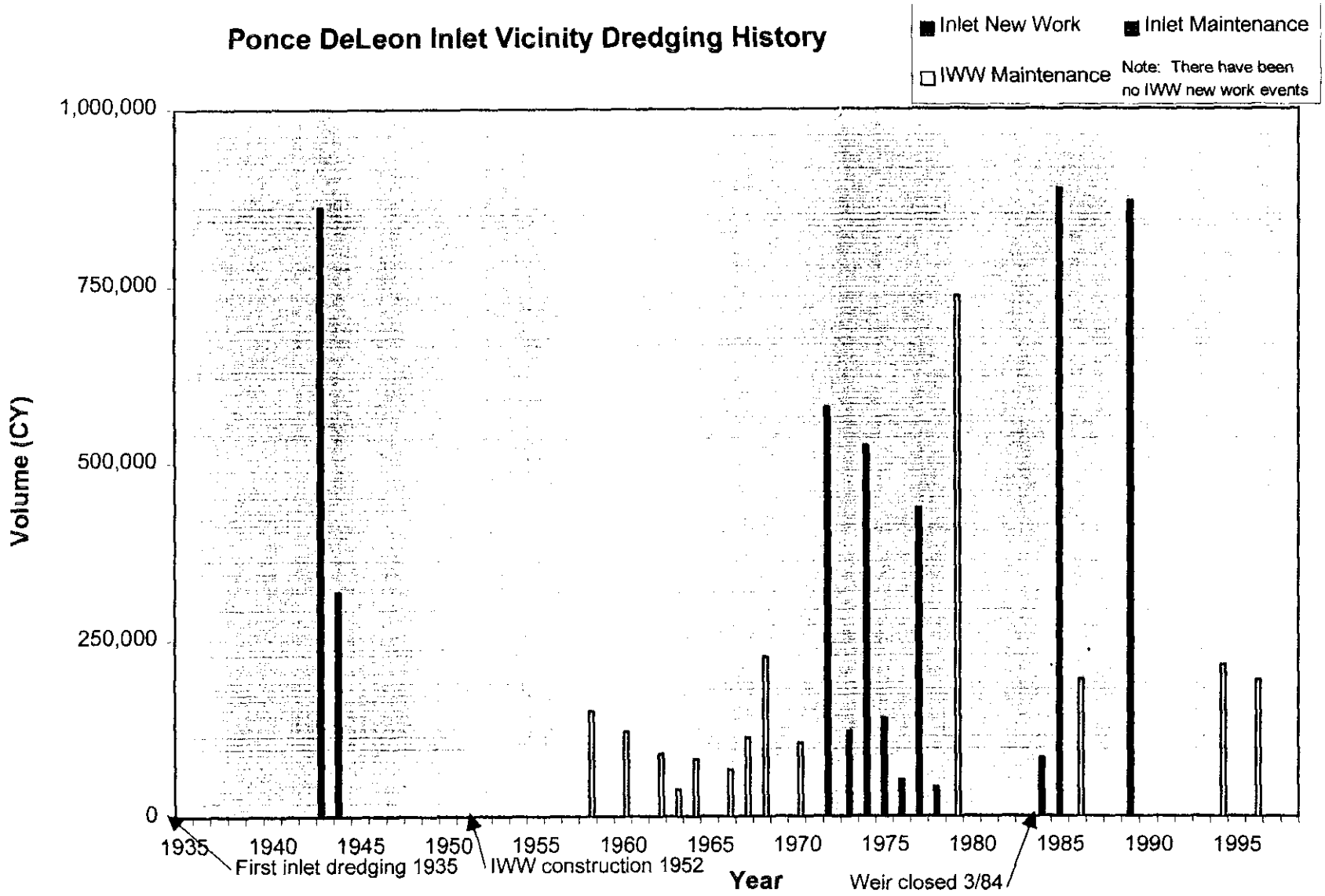
Ponce DeLeon Inlet Vicinity Dredging History
Inlet New Work
Inlet Maintenance
IWW Maintenance
Note: There have been no IWW new work events
1,000,000
750,000
500,000
250,000
0
Volume (CY)
1935
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
Year
First inlet dredging 1935
IWW construction 1952
Weir closed 3/84

Figure 23

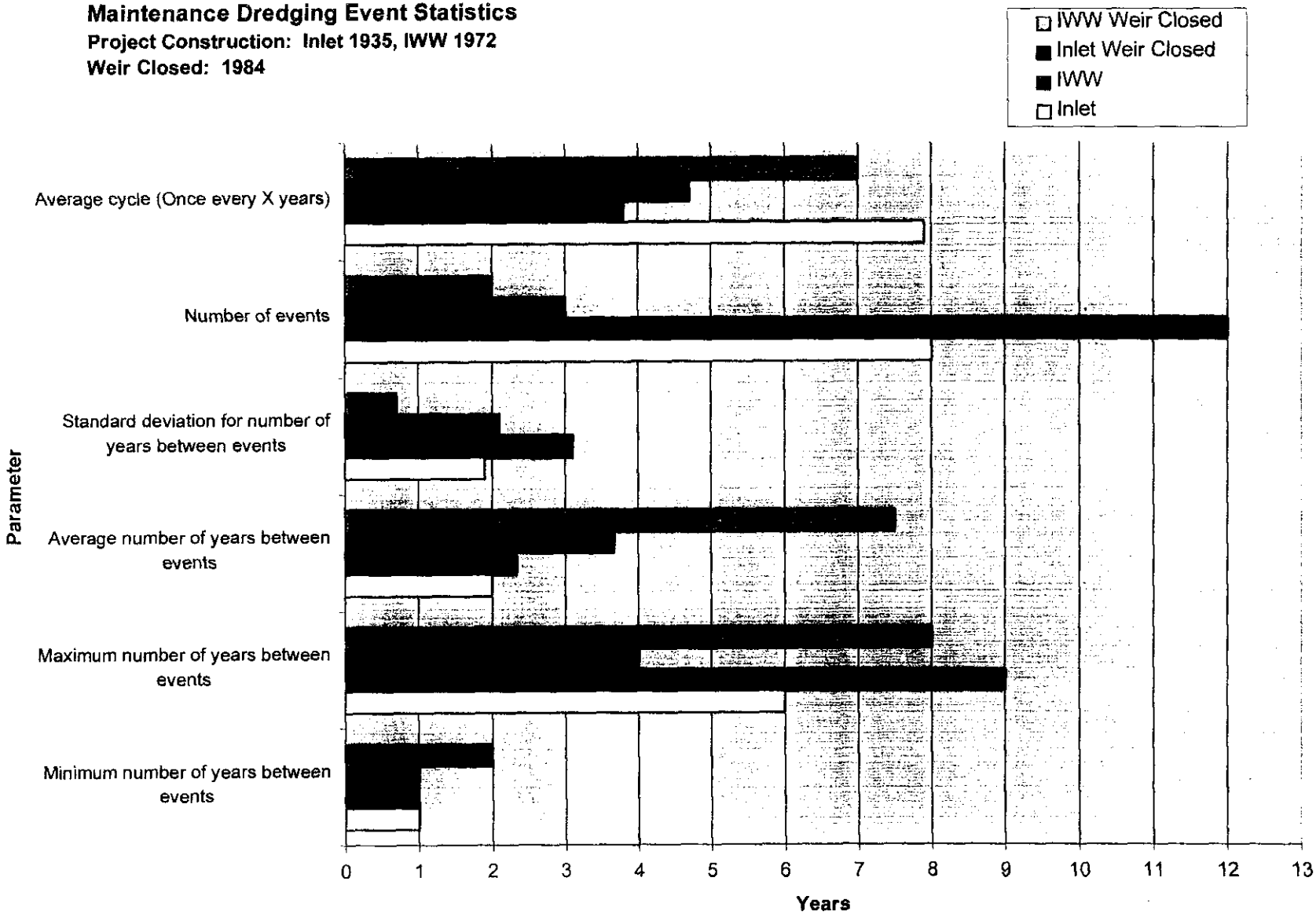
Maintenance Dredging Event Statistics
Project Construction: Inlet 1935, IWW 1972
Weir Closed: 1984
IWW Weir Closed
Inlet Weir Closed
IWW
Inlet
Average cycle (Once every X years)
Number of events
Standard deviation for number of years between events
Average number of years between events
Maximum number of years between events
Minimum number of years between events
Parameter
0
1
2
3
4
5
6
7
8
9
10
11
12
13
Years

Figure 24

177. With the 1,000-foot south jetty extension in place, 50,000 cubic yards of material are expected to be prohibited from entering the inlet system [including the Federal inlet project and the Federal Intracoastal Waterway (IWW) project, Cuts 22-29 (Taylor Engineering, July 1998, p.5)] per year (Taylor Engineering, July 1998, p.4). As a result shoaling rates will be reduced for both the inlet project and the IWW project. For the IWW a reduction of 80 percent is assumed for the 46,000 cy/yr shoaling rate, resulting in a with project shoaling rate of 9,200 cy/yr. Using a 10-year interval, each maintenance dredging event would remove 92,000 cy of material. The average annual equivalent with project maintenance dredging cost over the 50-year economic analysis period is $106,000. For the inlet, the with project shoaling rate is 6,800 cy/yr. Using a 10-year interval, each maintenance dredging event would remove 68,000 cy of material. The average annual equivalent with project maintenance dredging cost for the inlet over the 50-year economic analysis period is $84,000. Maintenance savings result when comparing the without and the with project conditions of $68,000 for the inlet and $120,000 for the IWW (AAEQ).

Table 13
Maintenance Cost Savings

	Without project			With project			Savings
	Shoaling rate	Dredging interval	AAEQ cost	Shoaling rate	Dredging interval	AAEQ cost	($)
	(cy/yr)	(yr)	($)	(cy/yr)	(yr)	($)	
Inlet	20,000	10	152,000	6,800	10	84,000	68,000
IWW	46,000	10	226,000	9,200	10	106,000	120,000

Note: Shoaling reductions are 36,800 cy/yr for the IWW and 13,200 cy/yr for the inlet, or 50,000 cy/yr for the entire inlet system.

178. Summary of Benefits. These benefits were computed based on the assumptions that new fish processing facilities will not be constructed and that the Corps will construct the 1,540-foot revetment and 800-foot landward extension associated with the north jetty under its operations and maintenance program. The potential project consists of Plan A (1,000-foot south jetty extension). AAEQ benefits for Plan A are the following: commercial vessel/use, $48,000; recreational vessel/use, $261,600; north jetty maintenance cost savings, $66,000; IWW maintenance cost savings, $120,000; inlet maintenance cost savings, $68,000. Total AAEQ benefits for the 1,000-foot south jetty extension (Plan A) are $563,600.

SENSITIVITY ANALYSIS

179. The cost estimates are sensitive to future market price levels and interest rates. They are also subject to the level of accuracy in the topographic, hydrographic and

geological data used as a basis for determining the size, placement, quantity, and type of stone used in design of the jetty extensions and the revetment. The area of the proposed work is well known from previous studies, numerical and physical modeling, and project work. Therefore, the degree of variation in estimates would be based more on differences between actual verses recorded data. Overall the estimates appear reasonable with the contingency item in the cost estimates likely to absorb any unforeseen increases.

180. The benefits are sensitive to projections of future conditions as shown in Tables 7 and 8. The variation in benefits between considered savings in reductions in damages to commercial vessels, opportunity costs saved in association with reductions in physical damages, harvest yield foregone, operations costs for diversions and delays, net income associated with business lost or foregone for charter fishing vessels, and savings in damages to commercial docks and marinas is related to stabilizing the inlet system channels. The potential for stabilizing the inlet with the combination of measures selected is good, based on results of numerical and physical model tests. The difference between the with- and without-project conditions tested by the models combined with a detailed review of past historical data as well as interviews of inlet users helps assure a greater probability of success in selection of effective measures for inlet stabilization. The potential that the benefits are overstated is small, based on information and support from the model testing program and inlet users.

181. The environmental impacts outlined in the environmental assessment are sensitive to individual interpretations of field data and on-site inspections. Although some variance may occur in the estimated impacts, the relative environmental impacts between the alternative plans and the without project (no action plan) conditions in the Environmental Assessment depend on the ability of the inlet system channels to naturally realign with improvements and the estimates for the rates of erosion of the remaining sand spit west of the north jetty. Once Plan A is constructed, the entrance channel is expected to move away from the north jetty along with related interior channel shifts, based on model testing. Erosion of the sand spit west of the north jetty continues as predicted by shoaling analysis and past historical data. The only variable is how fast erosion will occur since a major storm could accelerate that process. Basically, the alternative plans involve extensions of already existing structures. The ocean extension of the south jetty and the landward extension of the north jetty with an additional revetment appendage are necessary for inlet stabilization. The net overall result of both extensions saves wetlands and provides added environmental values.

182. Specific to the maintenance dredging benefits for Plan A, there is uncertainty in the following:

- the cumulative inlet interior shoaling rate,
- the amount of sediment that will be prohibited from entering the inlet system as a result of the construction of the 1,000-foot south jetty extension,
- the distribution of that sediment within the inlet system, and

- the maintenance dredging cycles used in the with and without project maintenance dredging scenarios.

183. In the supplemental report entitled, "Engineering Benefits of the Proposed South Jetty Extension", the cumulative inlet interior shoaling rate is determined two ways. One way used both changes in inlet bathymetry and historical dredging records. Comparison of changes in inlet bathymetry yielded volume change rates of 22,300 and 9,900 cubic yards per year (cy/yr) for the periods 1990-1994 and 1986-1994. This range was rounded to 20,000-10,000 cy/yr in the supplemental report. An examination of historical dredging records for the IWW since weir closure in 1984 yielded an average dredging volume of 46,000 cy/yr. The cumulative inlet system shoaling rate range of 56,000-66,000 cy/yr is the sum of the 10,000-20,000 cy/yr range and the average dredging volume of 46,000 cy/yr. The second way is by estimating littoral drift rates using the GENESIS shoreline change model (Hanson and Kraus). The northerly longterm (over 10 year) transport rate resulting from the model work is between 55,000 and 60,000 cy/yr along the beach until about two miles south of the inlet. The ranges 56,000-66,000 and 55,000-60,000 cy/yr match well.

184. The amount of sediment that will be prohibited from entering the inlet system as a result of construction of the 1,000-foot south jetty extension is about 80% of the current backpassing volume (Taylor Engineering, July 1998, Ch. 3). Taking 80% of the minimum and the maximum of the ranges presented in the previous paragraph, 55,000 cy/yr and 66,000 cy/yr, yields a range of 44,000-52,800 cy/yr for the amount of sediment that will be prohibited from entering the inlet system. The amount from which the maintenance dredging savings benefit is calculated is 50,000 cy/yr. This amount seems reasonable given the possible ranges.

185. The distribution between the Federal inlet project and the Federal IWW project of the amount of sediment to be prohibited from entering the inlet system was determined using the 50,000 cy/yr as a base, as well as the volume change range of 10,000-20,000 cy/yr for the inlet project and the average of 46,000 cy/yr for the IWW project. It was assumed that 80% of the 46,000 cy/yr, or 36,800 cy/yr, would be kept from entering the dredgeable areas of the IWW with the project (with 1,000-foot south jetty extension). The reduction in the dredging rate for the inlet project would be 50,000 cy/yr minus 36,800 cy/yr or 13,200 cy/yr. Using 20,000 cy/yr for the average dredging rate for the without project condition, this is 6,800 cy/yr, a 66% reduction. A more aggressive scenario could have used 100% for the IWW reduction initially and less over time. In this case the percent reduction for the inlet project would have been zero initially and would have increased over time.

186. In reference to the with and without project maintenance dredging cycles, the following assumptions were made: for the IWW project, the with project cycle is one maintenance dredging event every seven years and the without project cycle is one event every 10 years; and for the inlet project, the with project cycle is one event every 10 years (advanced maintenance included) and the without project cycle is one event every 10 years. The with project IWW cycle was calculated by averaging the number of

events since weir closure. The other cycles use the maximum cycle felt reasonable for a Federal navigation project in Florida, considering non-uniform shoaling and storm events. Uncertainty in these cycles might be lessened by using a Monte Carlo simulation or some other probability technique for maintenance dredging events (this could be done for both amounts and cycles-see Table 13 for a complete list of amounts and cycles).

187. Another method of dealing with uncertainty in the amount of sediment to be trapped by the 1,000-foot jetty extension and in the distribution of sediment deposition in the Federal inlet project and the Federal IWW project would be to use a more refined analytic technique for sediment movement. For example, a fluid bed sediment model could be used to analyze sediment movement within the inlet system.

PLAN SELECTION

188. The formulation and evaluation process requires inclusion of structural and nonstructural alternatives in a final analysis. The natural realignment and stabilization, after construction of the south jetty extension, of the entrance channel away from the north jetty along with related gradual adjustments of the north and south Federal channels in the inlet throat is part of the nonstructural alternative. The associated natural erosion of the sand spit west of the north jetty will occur with the nonstructural plan. The structural alternative is Plan A.

189. Plan A consists of a 1,000-foot extension of the south jetty parallel to the existing north jetty (figure 11). It provides the most effective alternative in reducing sediment transport around the tip of the jetty without adversely impacting navigation within the inlet. It provides the most uniform flow distribution across the width of the inlet as well as smaller increases in velocities and lowers the hydraulic pressure along the south side of the north jetty. Model testing shows that the changes to inlet hydrodynamics resulting from construction of the 1,000-foot extension of the south jetty mainly affect the outer portion of the inlet in the entrance channel area as shown in figures 7.5 and 7.6 of the Volume II of the 1996 Taylor Engineering Report.

190. The nonstructural plan takes effect after Plan A is implemented. It consists of allowing the entrance channel to naturally realign itself toward the center of the inlet. Instead of dredging the entrance channel to force it back into its authorized location between the two jetties, a gradual shifting of the channel towards the center of the inlet is expected to produce the natural realignment as a result of Plan A. That process will be helped as the natural erosion of the sand spit west of the north jetty continues to allow the entrance channel to straighten out in a more east to west orientation. Erosion of the sand spit west of the north jetty will be stopped at the point of the 1,540-foot revetment to be constructed by the Corps under the operations and maintenance program.

191. Dredging the entrance channel to help it reorient itself towards the center of the inlet is neither cost effective nor practical. Past experience with dredging to maintain an authorized Ponce DeLeon Inlet channel in an area where deep water did not exist has proven to be ineffective and cost prohibitive. Current practice involves a flexible maintenance plan which shifts buoy locations to areas of existing deep water instead of trying to maintain the originally authorized channel locations.

192. The no-action plan (the without project condition) is as described on page 57, with the addition of the 800-foot landward extension of the north jetty and the 1,540-foot revetment in the vicinity of the north spit, which are assumed to be constructed under the operations and maintenance program by the base year, 2001.

193. Table 14 summarizes these three alternatives.

Table 14
Comparison of Refined Alternatives[1]

Plan A		No Action Plan	Non-structural Alternative
Annual Benefits	$564,000	• High north jetty maintenance costs • Undesirable spit erosion • North jetty outflanking	• Takes effect after Plan A is implemented • Natural realignment of entrance channel away from north jetty
Annual Costs	$438,000		
Net Benefits	$126,000		
Benefit to Cost (B/C) /Ratio	1.29		

[1]When the proposed fishing park dropped out from further consideration, the alternatives for plan selection had to be refined. The refinement resulted in the three alternatives presented in this table.

194. Plan A meets the economic criteria for selection and is environmentally acceptable.

195. NED Plan. The Federal objective of water resources planning is to contribute to national economic development consistent with protection of the nation's environment. Plan A is selected as the national economic development (NED) plan. Plan A is the construction of a 1,000-foot south jetty extension parallel to the north jetty, with scour apron.

196. The selected orientation and selected length of the south jetty extension are products of the model study. In the model study, two orientations (parallel to the north jetty and straight) and two lengths (500-foot and 1,000-foot) were considered. Longer lengths were eliminated prior to the start of the model study since they would involve more cost with no additional benefits. The selection of the 1,000-foot length and parallel orientation was made based on the following summary from the Taylor Engineering report, 'Numerical Modeling and Shoaling Analysis, Volume II, November 1996 (p. 7-36)':

> The straight extensions produce the most dramatic changes; however, some of the changes are undesirable, such as reduced velocities in the middle of the entrance and increased velocities near the existing scour hole along the north jetty. Therefore, the two straight extension alternatives were discarded as viable solutions. Both parallel extensions produce generally desirable hydraulic effects, that is, increased and more uniform velocities across the jetty entrance and reduced velocities on the south side of the jetty extension and along the south beach. However, the hydraulic effects of the 1,000 ft parallel extension are much greater than the effects of the 500 ft extension and are more likely to produce the desired bathymetric response-that is, a more stable and uniform entrance channel which will (1) reduce maintenance dredging requirements, (2) produce safer navigation conditions (reduce the threat of vessel grounding or collision with the north jetty), and (3) reduce the threat of undermining of the north jetty, a key element of the navigation project. Furthermore, physical model results indicate the 1,000 parallel extension (1) provides much more protection against sediment moving into the inlet from the south, and (2) produces small, insignificant increases in wave height between the jetties due to wave-current-bathymetry interaction (not expected to advesely [sic] impact navigation).

197. The jetty extension with the 1,000-foot length and parallel orientation is selected over extensions of longer length and over an extension with a 500-foot length because it results in the most benefits for the cost.

THE SELECTED PLAN

198. The selected plan for navigation improvements at Ponce DeLeon Inlet is responsive to sponsor needs and desires as well as the economic and environmental criteria established by Federal and State law. To do this the plan must be able to handle current and forecasted vessel traffic safely with minimum impact on the environment and without excessive delays and damage. Subsequent paragraphs outline the design, construction, operation and maintenance procedures for the selected plan as well as summarize the plan's economic and environmental effects. For more detailed information on design, refer to appendix A. Refer to appendix D for an economic analysis. For environmental matters refer to the Environmental Assessment (EA).

SOUTH JETTY SEAWARD EXTENSION DESIGN

199. The selected plan provides for construction of a 1,000-foot extension to the south jetty, with a scour apron. The purpose of the south jetty extension is to reduce the northward transport of material into the inlet and to distribute tidal currents more

evenly across the inlet throat. The 1,000-foot extension of the south jetty will bring the seaward end of the south jetty to approximately the same eastern limit as the north jetty, as shown in figure 11. The design cross-section of the south jetty extension is shown in Appendix A on Figure 4. Side slopes are 1 on 1.5, and the crest elevation is +7 feet, mean low water (MLW). The crest width is 15 feet (a minimum of 3 stones). A taper will provide a smooth transition from the existing jetty's 10-foot width to the extension's 15-foot width. The seaward end of the south jetty extension consists of 8 to 12-ton armor stones, 500 to 2,500-lb core stones (50 percent weighing 1,500 lb. or more), and a gradation of bedding stone from 1 to 12 inches. The weights of armor and core stone required for construction are 165 lb/cubic foot. Bedding stone tonnages are based on a unit weight of 140 lb/cubic foot.

200. A 30-foot scour apron will be constructed on the north side of the south jetty to prevent damage to the jetty from the scouring which is expected upon completion of the extension. The stone to be used for the scour apron is 500 to 2,500 lb. stone, with 50 percent of the stones weighing 1,500 lb. or more. The scour apron will be four feet thick.

201. Both the jetty extension and the scour apron are underlain be a bedding layer. The bedding layer is two feet thick. It is constructed using standard gradations for limerock.

202. Total quantities of material required for construction of the south jetty extension are the following: 32,740 tons of 10-ton armor stone, 12,856 tons of 1,500-lb. core stone, 10,307 tons of bedding stone, and 11,780 square yards of filter fabric. The jetty extension will be 100 percent sand tight up to elevation –3 MLW. From –3 to +7 MLW the jetty be permeable.

203. The jetty extension alignment runs across a shoal on the south side of the inlet. Water depths average 6-10 feet along the alignment. Approximately 25,000 cubic yards of material will be excavated during construction of the jetty extension. Excavated material will be placed on the south side of the extended jetty as shown on Figure 11.

NAVIGATION AIDS

204. The United States Coast Guard (USCG) has the responsibility to provide and maintain the proper number of navigation aids needed for day and night navigation on a Federal project. The estimated cost, as provided by that agency is $4,000. The $12,000 amount shown in Table 9 includes the $4,000 plus costs for fabrication of a concrete foundation by the Corps at the seaward end of the south jetty extension. The Corps will mount a USCG supplied tower on the foundation. Once the tower is placed, the USCG will install a solar powered warning light. Appendix C contains their letter dated August 9, 1996 and describes annual maintenance costs of approximately $250

a year for the new equipment. No additional aids to navigation or related costs are required for the expected channel realignment.

REAL ESTATE REQUIREMENTS

205. The selected plan features will be constructed on lands owned by the Federal government or the State. For more details on lands see the Real Estate appendix B.

CONSTRUCTION

206. The selected plan calls for the construction of a 1,000-foot seaward extension of the south jetty, with scour apron. Staging areas for storage of jetty stone include existing public lands. On the south side of the inlet, the area leased by the sponsor from the Federal government includes an area of 250 acres with a perpetual pipeline and stockpile easement. The sponsor has used this area of the park for past maintenance. That site is within the project construction limits.

207. Since sufficient core boring information was obtained during the feasibility study, no additional pre-construction drilling is required. Other pre-construction activities will include hydrographic surveys of the seaward south jetty extension location.

208. Construction of the seaward south jetty extension will most likely involve barge-mounted equipment using ocean access. It may be possible to chink the existing south jetty and move equipment out on it for excavation and placing jetty stone. However, the same staging area mentioned above would still be used.

209. Environmental monitoring during project construction will require several activities. Installation of warning signs for manatee protection in the area of the south jetty extension will precede construction activities. Monitoring of sea turtles may be required if construction occurs during the nesting season. Although the Corps of Engineers does not have any responsibility for the foundation remains of the old Hotel Inlet Terrace, the sponsor may want to relocate an interpretive sign and part of the foundation. The sign and foundation may be located within the footprint of the 800-foot landward extension of the north jetty.

IMPACTS TO CHANNEL NAVIGABILITY CONDITIONS

210. Navigability of the channel will improve with the 1,000-foot south jetty extension in place. Both the physical model (U.S. Army Corps of Engineers, Waterways Experiment Station, Ch. 5) and the numerical model (Taylor Engineering, 1998, p.4) reveal that the deepwater channel is expected to migrate toward the south, away from the north jetty, after construction of the south jetty extension. With the deepwater

channel nearer the center of the jetties the safety concerns for the commercial vessels and for the recreational vessels should be alleviated. The shrimp vessels that traverse the inlet with their outriggers down for stability should be able to stay farther away from the recreational vessels anchored along the north jetty to fish. The recreational vessel operators who are unfamiliar with the inlet channels and who expect the deepwater channel to be in the middle of the jetties will be more likely to find it toward the middle and to not run aground on the shoal near the end of the entrance channel on the south side.

IMPACTS TO SURFING

211. Results of the numerical and physical model studies may be used to infer impacts to surfing south of the south jetty. The physical model includes three nearshore gages positioned to determine the effects of the south jetty extension on wave heights at the surfing area. With the 1,000-foot south jetty extension in place there is expected to be a 10 percent increase in wave height during ebb flow and no increase in wave height on flood flow as compared to existing wave conditions. Accretion is expected to occur south of the 1,000-foot south jetty extension and may result in a shifting of the most desirable surfing location to the south and east from its present location. A discussion of the impact of the 1,000-foot south jetty extension on surfing is found in the discussion on physical and numerical modeling of alternative plans in the Engineering Appendix, Appendix A, and on page 46 of the physical model study report in the discussion entitled, "Impacts of Preferred South Jetty Extension on Waves and Velocities."

FIRST COSTS

212. The estimated first cost of the selected plan is in Table 15. All costs are based on May 1997 price levels. Planning, engineering, design, and construction management costs are estimated based on actual experience for similar projects. There is no known relocation work required for construction. Lands needed for the project include access, staging, and stockpile areas. Access to any staging or stockpile areas will be by barge and/or public access. Those lands are owned by the Federal government, the non-Federal sponsor or are leased by the non-Federal sponsor. Real estate acquisition/administrative costs are shown in Table 15.

213. The estimated cost for construction of the 1,000-foot seaward extension of the south jetty is in the cost estimate of Table 15. Interest during construction in that table is for an equal dispersion of payments over a 23-month period. That duration consists of a 12-month preparation period for plans and specifications (planning, engineering, and design) plus 9 months for construction of the south jetty extension.

Table 15 Plan A	8/24/98
ITEM	COST
Construction Costs	
Plan A	$4,182,000
Total Const. Cost	$4,182,000
Real Estate Activities	
Aquisition/Administration Federal	$8,000
Aquisition/Administration Non-Federal	$12,000
Total Real Estate	$20,000
Navigation Aids	$12,000
Planning, Eng, & Design (PED)	$123,000
Construction Mgt	$207,000
Total Non-Construction Costs	$362,000
Contingencies	$910,000
Total First Costs	$5,454,000
Interest During Construction	$286,000
Economic Investment	$5,740,000

FUTURE OPERATIONS AND MAINTENANCE

214. Future operations and maintenance (O&M) costs for the south jetty 1,000-foot extension consist of costs for inspections and scour apron and armor layer repairs. Inspections are estimated at $1,000 once every three years. Anticipated repairs include one scour apron repair and crest elevation restoration midway through project period of analysis (year 2024) at an estimated cost of $1,017,000.

215. Future O&M costs for the inlet consist of maintenance dredging costs. Using 20,000 cy/yr as the shoaling rate and a 10-year interval, each future maintenance dredging event would then consist of 200,000 cy of material. No advanced maintenance analysis was conducted for the inlet since such an analysis would lengthen the interval between events and doing so would be unreasonable. Material dredged from the inlet is expected to be beach quality and to be placed south of the south jetty. The average annual equivalent value for placing 200,000 cy of material on the beach every 10 years over the period of analysis of the project is $152,000.

216. With the 1,000-foot south jetty extension in place, 50,000 cubic yards of material are expected to be prohibited from entering the inlet system [including the Federal inlet project and the Federal Intracoastal Waterway (IWW) project, Cuts 22-29 (Taylor Engineering, personal communication)] per year (Taylor Engineering, 1998, p. 4). As a

result shoaling rates will be reduced for both the inlet project and the IWW project. For the inlet, the with project shoaling rate is 6,800 cy/yr. Using a 10-year interval, each maintenance dredging event would remove 68,000 cy of material. The average annual equivalent with project maintenance dredging cost for the inlet over the 50-year economic analysis period is $84,000. The annual cost estimate includes no net increase for additional project maintenance since there are maintenance dredging savings for the inlet.

217. Construction of a $1.3 million scour apron was completed in July 1998 along the inlet side of the north jetty. With construction of the south jetty extension, the entrance channel is expected to shift away from the north jetty toward the center of the inlet. Removal of hydraulic pressure away from the north jetty should result in a reduction in north jetty maintenance. Estimated AAEQ maintenance costs for the north jetty without any navigation improvements are $89,000. With navigation improvements AAEQ costs for the north jetty are estimated at $23,000. An AAEQ savings of $66,000 results. The estimated reduction in current project features maintenance is more than the estimated maintenance cost for the 1,000-foot south jetty extension ($16,000). Therefore, the annual cost estimate includes no net increase for additional project maintenance.

ANNUAL COSTS

218. The estimated average annual equivalent (AAEQ) costs for the selected plan are shown in Table 16. The costs are presented as a function of two interest rates since the interest rate went down from 7 1/8% in late 1998 to 6 7/8% in early 1999. The first item of $403,000 is interest and amortization at 6 7/8 percent over the economic period of analysis of 50 years to pay back the economic investment cost of $5,454,000. The second item ($250) is the annual maintenance of an additional illuminated aid to navigation (ATON) to be placed on the offshore end of the proposed south jetty extension. The third item ($16,000 annually) is the cost for future maintenance on the 1,000-foot south jetty extension. The total AAEQ cost associated with the selected plan is $419,250.

Table 16 ECONOMIC SUMMARY OF THE SELECTED PLAN		
	AMOUNT (AAEQ)	
	Interest Rate=6.875%	Interest Rate=7.125%
ANNUAL COSTS		
Economic Investment	$403,000	$422,000
Navigation Aids	$250	$250
Future O&M (South jetty extension)	$16,000	$16,000
Total Annual Costs	$419,250	$438,250
ANNUAL BENEFITS		
Commercial Use/Activities	$48,000	$48,000
Recreational Use/Activities	$263,000	$262,000
North Jetty Maintenance Savings	$66,000	$66,000
AIWW Maintenance Savings	$121,000	$120,000
Inlet Maintenance Savings	$69,000	$68,000
Total Annual Benefits	$567,000	$564,000
NET BENEFITS	$147,750	$125,750
BENEFIT-TO-COST RATIO	1.4	1.29

ENVIRONMENTAL EFFECTS

219. During construction of the selected plan, species that could be affected are the saltmarsh snake, manatees and sea turtles. According to USFWS the saltmarsh snake could easily be captured at night and removed from the area; therefore this species should not be impacted by construction activities. Standard manatee and sea turtle precautions will be in effect during construction to minimize impacts to those species. If trucks are used to haul rock along the beach during construction of the south jetty extension, arrangements will be made to locate and move sea turtle eggs during the nesting season.

220. Six potentially significant submerged magnetic targets located outside a 400-foot wide construction easement containing the 105-foot wide footprint area of the south jetty extension will be included in archeological no-work zones. Diver investigation of another seven potentially significant magnetic targets within and around the 400-foot construction easement for the selected plan revealed modern materials with no historic properties.

BENEFITS

221. An evaluation of benefits to be derived from implementation of the selected plan is in appendix D. Benefits result from operational and transportation cost savings due to:

- Reductions in physical damages to all commercial vessels;
- Opportunity costs saved in association with reductions in physical damages;
- Harvest yield foregone for commercial vessels;
- Net income associated with business lost or foregone for charter operations;
- Operations costs for diversion and delays for charter fishing vessels due to inlet conditions;
- Opportunity costs saved in association with reductions in physical damages;
- Operations costs for diversion and delays for transient or seasonal commercial fishing vessels due to inlet conditions;
- Opportunity costs saved in association with reductions in physical damages;
- Reduction in damages to recreational vessels and value of time saved for inlet users.

222. To obtain average annual equivalent values all future values of projected benefits are discounted at an interest rate of 6 7/8 percent over a period of 50 years. The total average annual benefits for the selected plan are $567,000. A summary of those benefits is in Table 16. The benefits are presented as a function of two interest rates since the interest rate went down from 7 1/8% in late 1998 to 6 7/8% in early 1999.

ECONOMIC SUMMARY

223. On the selected plan the benefits exceed the costs by $147,750 annually ($567,000-$419,250). The benefit to cost ratio is equal to the total average annual equivalent benefit of $567,000 divided by the total average annual equivalent cost of $419,250. That ratio is 1.35 to 1.00.